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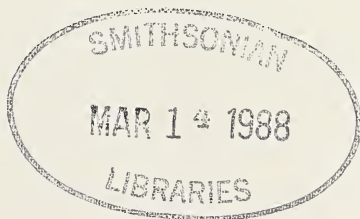
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The Maryland Herpetological Society
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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

A POPULATION ESTIMATION TECHNIQUE FOR AQUATIC TURTLES

Donald A. Ingold, Susan E. Willbern and Douglas M. Roberts

Abstract

A multiple census population estimation technique (Schnabel method) was applied to a red-eared turtle (*Pseudemys scripta elegans*) population on a three-acre farm pond. The technique seems to be especially suitable for aquatic turtle populations. The last eight of 13 estimates were essentially asymptotic (which greatly enhances one's confidence in the data obtained). The mean of these eight values was about 209 which indicates that there were approximately 70 adult red-eared turtles per surface acre.

Introduction

During the 1890's, C. G. J. Peterson began the practice of using marked fish to compute both the rate of exploitation and the size of the fish population in an enclosed body of water. The method is still widely known as the Peterson method (or as the "mark-and-recapture method" or the Lincoln Index). This simple, single census method involves releasing marked individuals into a wild population and then at a later time taking a single sample of that population and examining it for marked individuals. An estimate of the size of a population is derived by the formula $\hat{N} = MC/R$ where $\hat{N}$ is the estimate of population size, M is the number of marked individuals released into the population, C is the total number of individuals captured in a single sample, and R is the number of recaptures (= marked individuals in the sample).

The reliability of estimates obtained by this method depends partially upon the following assumptions: (1) no recruitment to the population from younger age classes or via immigration occurs during the sampling period, (2) differential mortality of marked vs. unmarked animals does not occur as a result of the marking procedures or handling, (3) animals in the marked population do not lose tags (or marks), and (4) marked animals become randomly distributed throughout the population (Ricker, 1958).

In the 1930's Ms. Zoe Schnabel, working with Dr. Chancey Juday at the University of Wisconsin, developed a multiple census method in which the recapture data are obtained concurrently with the performance of the marking operation (Schnabel, 1938). This multiple census method (known simply as the Schnabel method) generates far more reliable population estimates than a single Peterson estimate.

We applied the Schnabel method to the red-eared turtle (*Pseudemys scripta elegans*) population on a three-acre farm pond on the East Texas State University Agricultural Farm about 7.2 km south of Commerce, Texas.

Methods

A floating box trap (90 cm x 75 cm x 60 cm) was constructed of wood and woven wire. The top of the box remained open, and all other sides were enclosed with woven wire. Split hardwood logs were fastened to the open rim of the trap, and these floated on the surface when the trap was placed in water. Ten-centimeter nails were pounded into the logs at 3.8 cm intervals, at about 45° angles (inward) and with about 7.6 cm of each nail protruding. The nails made it impossible for most turtles to leave the trap once they had entered. A wire screen bait basket was suspended between the logs, and fish were used as bait. Five capture stations (at 46 m intervals) were established along the length of the pond, and the trap was anchored at each station for 24 hrs during a five-day sampling period.

All captured turtles were marked with small, numbered brass tags and released at capture sites. Tags were attached with stainless steel wire through two tiny holes drilled through the trailing edge of the carapace. Data were collected during 14 five-day sampling periods that occurred on alternate weeks over a six-month study period (June through November). An estimate of the size of the red-eared turtle population was calculated at the conclusion of the second sampling period and at the end of all subsequent sampling periods (total = 13 estimates) using the Schnabel method (i.e., the cumulative data at a given point in time). The Schnabel formula, using cumulative data, is: $\hat{N} = \Sigma(C\Sigma M) / \Sigma R$ (with letter components of the formula as previously defined).

Results

Of 152 total captures (C_t) during this study, 113 individuals were marked (M_t) and 39 were recaptures (R_t). The final population estimate, derived by dividing the final entry in the $\Sigma(C\Sigma M)$ column by the final entry in the ΣR_t column (8323/39), was 213 (Table 1). Although the 13 population estimates obtained vary from 94 to 219, the last eight estimates are asymptotic (Figure 1) and vary only from 196 to 219. The mean of the last eight estimates is 209.125 (with 95% confidence limits of 209.125 $\pm$ 7.705, or 201.42 to 216.83).

Discussion and Conclusions

The first estimate (=94) is essentially a single-census Peterson estimate. Confidence in subsequent estimates increases as values become asymptotic. The Schnabel (multiple census) method seems to be especially appropriate for estimating adult turtle populations because the major assumptions for minimizing bias are probably more closely met than for most

Table 1. Population Estimates (in Last Column) Using the Schnabel Modification of the Peterson Index

Sample No.	Number Caught C_t	Recaptures R_t	Number Marked M_t	ΣM_t	$C_t \Sigma M_t$	$\Sigma(C \Sigma M)$	ΣR_t	$\hat{N} = \frac{\Sigma(C \Sigma M)}{\Sigma R_t}$
1	27	2	25	0	0	0	2	0
2	15	2	13	25	375	375	4	94
3	10	2	8	38	380	755	6	126
4	18	8	10	46	828	1583	14	113
5	3	1	2	56	168	1751	15	117
6	15	1	14	58	870	2621	16	164
7	10	1	9	72	720	3341	17	197
8	24	10	14	81	1944	5285	27	196
9	9	3	6	95	855	6140	30	205
10	1	0	1	101	101	6241	30	208
11	16	6	10	102	1632	7873	36	219
12	2	1	1	112	224	8097	37	219
13	1	1	0	113	113	8210	38	216
14	1	1	0	113	113	8323	39	213

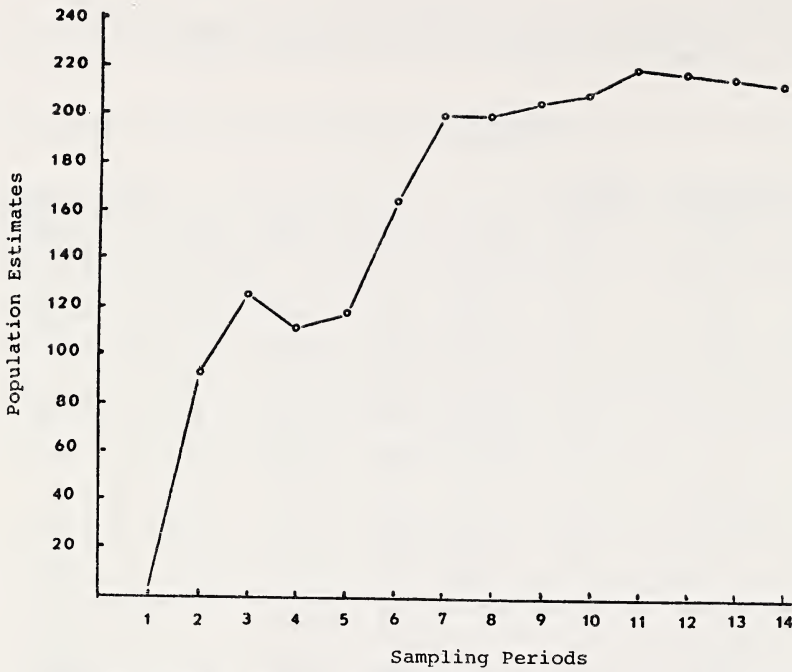


Figure 1. The last eight of 13 population estimates are approximately asymptotic.

fish populations for which the method was originally designed. Conditions concerning the four assumptions for aquatic turtle populations are as follows. (1) Recruitment from younger age classes will probably be negligible over relatively short study periods because of the slow rates of growth of most turtles. Such studies should begin after the summer dry season begins in order to minimize recruitment of immigrants (emigration of aquatic turtles typically occurs during wet, rainy periods). (2) The most common methods used for marking aquatic turtles do not interfere with longevity and consequently will not cause differential mortality. (3) No tags were lost, although the loss would have been detected by the holes drilled in the margin of the carapace. A variation of Cagle's (1939) shell notching which can be done with a 3-cornered file would eliminate the possibility of lost tags. (4) In relatively small ponds (1-3 acres), marked turtles probably become randomly distributed throughout the population. This possible source of error can be minimized by using several sampling stations as we did. However, this may not be necessary since turtle #8 was captured at four of the five sampling stations, and another turtle (#34) was captured at all five sampling stations, including two captures at both stations I and V. These captures occurred over an 84-day span with a minimum span of only eight days between captures at stations I and V.

A major limitation of our capture method was that it did not capture juvenile red-eared turtles. In fact no turtles were captured with plastron lengths less than 9 cm. Two prominent explanations exist for the exclusion of small turtles: (1) our trapping stations were at 46 m intervals in the middle of the pond, and very small turtles stayed near the shoreline, and (2) protruding nails on the rims of the floating split logs were spaced at 3.8 cm intervals and very small turtles could possibly leave the trap between adjacent nails. However, it should be noted that small turtles were never seen basking on these logs and probably did not frequent the middle of the pond.

The three-acre pond had approximately 209 post-juvenile (plastron length >90 mm) red-eared turtles, or about 70 per surface acre. This is considerably less than Gibbons' (1968) estimate of 147 post-juvenile *Chrysemys picta* per acre on 10 acres of Sherriff's Marsh in southwestern Michigan. Thirty-seven percent of the total population of Sherriff's Marsh were juveniles (<80 mm). If a similar segment of the population were juveniles in our pond, there would be about 123 juveniles, and a total population of 332 red-eared turtles.

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NOTES ON THE REPRODUCTION OF THE
SHORTHEAD GARTER SNAKE, *Thamnophis brachystoma*

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The shorthead garter snake, *Thamnophis brachystoma* has a restricted range in northwestern Pennsylvania and adjacent southwestern New York, and appears to be a relictual Pleistocene species. It apparently avoids deep woodlands and inhabit open fields, meadows and marsh borders. It is a relatively poorly known species (see Bothner, 1976, for a review of the literature on this snake), and for this reason we thought it proper to present some additional data concerning birth and neonates.

Mating occurs in April just after emergence from hibernation, and Pisani (1967) has described courtship behavior. Sperm from these matings is apparently stored in seminal receptacles in the oviduct until the eggs are ovulated in May or June (Pisani and Bothner, 1970). The young are born in August and September (Table 1). Pisani and Bothner (1970) felt that female *T. brachystoma* probably have a biennial reproductive cycle, as 25% of the mature females examined between May and September showed no signs of ovulation that year (no enlargement of mature ovarian follicles, no embryos, no recent corpora lutea). Pisani and Bothner thought such a cycle possibly an adaptation to a habitat where short, cool summers are common.

Two female *T. brachystoma* were collected on 29 July 1985 in Forest County, Pennsylvania by Dr. C. J. McCoy, Carnegie Museum of Natural History and were given to the senior author on 5 August. On 14 August, the smaller female (41 cm total body length, 17.6 g postpartum) gave birth to five young (139-145.5 mm TBL; 3 live, 2 stillborn). Unfortunately, the birth process was unobserved. On 20 August, the larger female (41.5 cm TBL, 17.3 g postpartum) gave birth to a litter of eight (118-145 mm TBL; 5 live, 3 stillborn). On this occasion the senior author witnessed the parturition of the last two young. The female was found at 0653 hr. with one-fourth of the seventh neonate protruding from her cloaca as she slowly crawled about the cage. Total passage of this young took an additional 70 seconds. Ninety seconds later the eighth young began to emerge and its birth was completed in 102 seconds. Again, the female crawled around the cage during its birth. At no time were any contractions of the female's body wall observed. Both young were enclosed in their fetal membranes, and, since both were stillborn, no observations were made of emergence from these membranes. A search of the cage revealed 5 young already free of their membranes and another dead individual wrapped in its membrane. In both this and the earlier litter, the live young had already shed their skins or were in the process of doing so. No complete sloughs were found, instead the ecdysis occurred in strips. The young either attempted to flee when first approached, or formed a tight coil. When first handled they defecated or musked, but made no attempts to bite. The young of the first litter were preserved in the collection of George Mason University (GMU 2704-2708), and the second female and her young were

Table 1. Summary of litter size and neonate data for the snake,
Thamnophis brachystoma (measurements in mm, weights in g).

Date	Litter (Sample) Size	Total Length	Mean		Tail Length Total Length	Weight	Source
			Snout-Vent Length	Tail Length			
July 10	6 (embryos)	~ 90					Swanson, 1952
25	9 (near-term young)						Stewart, 1961
Aug. 5	6	125-133					Swanson, 1952
14	5	142.8 (139-145.5)	108.4 (104-112)	34.4 (32-35.5)	24.1 (22.2-25.2)	1.2	Ernst & Gotte, 1985
15	21 (3 females)	143-153					Swanson, 1952
16-17	5	145-147					Swanson, 1952
20	12	135-158					Swanson, 1952
20	8	132.6 (118-145)	103.5 (93-108)	29.1 (25-33)	22.0 (20.8-23.5)	1.07 (1.0-1.2)	Ernst & Gotte, 1985
Sept. 10	11	125-138					Swanson, 1952
	20 (2 females)	147					Richmond, 1954
	*12 (males, 3 litters)	146.4					Barton, 1956
	*15 (females, 3 litters)	146.0					Barton, 1956
	males	130.7	99.1	31.6	24.1		Pisani & Bothner, 1970
	females	129.9	100.4	29.5	22.7		Pisani & Bothner, 1970

* Same litters

preserved and placed in the collection of the United States Museum of Natural History (USNM Herp. Field #145568-145575). The young resemble the adults in pattern, but are somewhat darker in ground color.

Pisani and Bothner (1970) calculated the mean reproductive potential of their females was 7.2 young per litter; average 2.4 (1-4) embryos in the left oviduct and 4.8 (2-8) in the right. Litter sizes recorded by Swanson (1952) averaged 8.6 young (5-14), so the number of young in the two litters reported in this note fall within the normal range. A plot of litter size versus female TBL (Figure 1) for the five litters in which female size is known indicates a general correlation.

A plot of neonate weight versus their TBL also indicates a general correlation, as expected (Figure 2). The combined weight to the five young of the first litter was 6 g, 34.1% of the female's postpartum weight. In the second litter, the eight young weighed a total of 8.6 g, 49.7% of the postpartum weight of the female.

Pisani and Bothner (1970) estimated that female *T. brachystoma* mature at a TBL of 33 cm during their second year. Our females were probably in their third year of life.

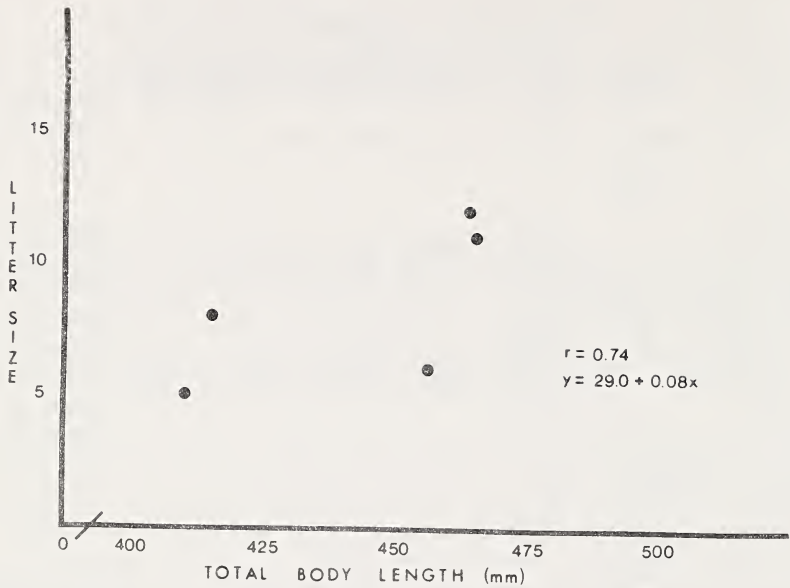


Figure 1. The relationship of litter size to female total body length in the snake, *Thamnophis brachystoma*.



Figure 2. The relationship of weight to total body length in neonate *Thamnophis brachystoma*.

Acknowledgements

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THE SPECIFIC NAME FOR THE LINNAEAN *Oxyrhopus*,
OR THE CALICO FALSE CORAL SNAKE

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Linnaeus proposed four names in 1758 and 1766 for two nominal species of *Coluber*, all now applied to a single species of *Oxyrhopus*, the only one of that genus for which he is credited, although it is the most widely distributed of the eleven species of *Oxyrhopus* recognized by Bailey (1970). Linnaeus' species has borne his name *petolarius* in some works (e.g., Ruthven, 1912:326; Neill and Allen, 1959:55), *petola* in others (e.g., Bailey, 1970:232). Indeed, the latter name is accepted by all current workers, following Amaral (1926:13-16), whereas the correct name is *petolarius*.

The 1758 (10th) edition of Linnaeus' *Systema Naturae* introduced the names *Coluber petola* and *Coluber petolarius*, both on p. 225, the former with position precedence over the latter. The 1766 edition (12th) of the same work used the emendations *Coluber pethola* and *Coluber petalarius* for the same taxa, again on the same page (387) and with position precedence for *C. pethola*. Both of the 1766 names are unjustified emendations of the earlier (1758) names, hence are junior synonyms of their earlier versions, as all workers this century have agreed, although Boulenger construed the 12th edition as the original in his monumental catalog of snakes (1896:101), thus citing the unjustified spellings (however, regarding *petalarius* as a misspelling of *petolarius*, the name he adopted over *pethola*).

Therefore the proper name of Linnaeus' species is narrowed to either *petola* or *petolarius*. The most widely noted choice was made in 1926 by Amaral (1926:13-16). On the basis of a recommendation (in Art. 28) in the then-operative (1905 edition) International Rules of Zoological Nomenclature, to wit that, in choosing between two names of the same date, "Other things being equal, that name is to be preferred which stands first in the publication," Amaral concluded that the name *Coluber petola* must be given preference over *C. petolarius*, because it occurs first on the page, and because it appeared earlier (1734, 1749) than the latter (1754) in the pre-1758 literature. The quoted section, however, is a recommendation only, not a mandate, and certainly other factors are not equal; the first reviser (Art. 28 of the 1905 edition, Art. 24 of the 1985 edition of the International Code of Zoological Nomenclature), explicitly, and by mandate, determines nomenclatural priority, not position precedence, although the recommendation cited by Amaral still stands (Rec. 24A) as a guide for the first reviser.

As noted by both Amaral (1926:15) and Bailey (1970:232), Lönnberg (1896:7) was the first reviser, and his selection should stand unless an appeal is made to the International Commission on Zoological Nomenclature to set aside his selection in the interest of nomenclatural stability. Both Amaral and Bailey (loc. cit.), however, interpreted Lönnberg's selection as

Coluber petola, but in error. Lonnberg's statement, following a discussion of the holotype of *Coluber petola* (for which he accepted the later emendation to *C. pethola*) and comparison of it with Linnaeus' *C. petolarius*, is: "No doubt therefore remains that *Coluber pethola* and *C. petolarius* are identical. The present name is: *Oxyrrhopus petolarius* [in boldface] Linnaeus, which is hereby made synonymous [i.e., senior] to *Coluber pethola*. Wagler is the author of the name *Oxyrrhopus* (1830), and the Linnaean species *petolarius* is recognized by all later authors." As examples of "later authors," Lönnerberg cited Duméril, Bibron and Duméril (1854), Günther (1858) and Jan and Sordelli (1870).

Lönnerberg's selection was eminently appropriate at the time, since the usage of *petolarius* had greatly exceeded that of *petola*; furthermore, the current code requires acceptance of his selection under application of its Art. 24, as did earlier editions. We have considered whether an appeal to the Commission for exclusion of Lönnerberg's choice would be justified in the interest of nomenclatural stability. The relative paucity of references to the species, even in taxonomic literature (with very few in popular and other non-taxonomic contexts, and only seven noted in the Zoological Record since 1958); the continued at least occasional use of the name *petolarius* at least until 1959 (Neill and Allen); and the provisions of Art. 79(c)(1) of the 1985 Code (failure of use of the senior name during the past 50 years, which is not true in the present case), lead us to conclude that nomenclatural stability has really not yet been attained (in 50-year terms), that the species does not attract sufficient attention to justify an appeal for suspension of the rules of the Code, and that unfettered application of those rules will provide the desired stability.

Thus the proper name for this species is *Oxyrrhopus petolarius* (Linnaeus), with the subspecies (according to Bailey, 1970) *O. p. petolarius*. *O. p. digitalis* (Reuss) and *O. p. sebae* Duméril, Bibron and Duméril, plus Duellman's (1963:246) and Stuart's (1963:109) *O. p. aequifasciatus* Werner.

It may be noted that *Oxyrrhopus* Wagler (1830:185) was unjustifiably emended as *Oxyrrhopus* by Fitzinger (1843:27); the latter name is nomenclaturally occupied, but is not available for use (being an objective junior synonym of *Oxyrrhopus*) so long as Wagler's name is available.

Wagler (loc. cit.) included three nominal species in *Oxyrrhopus*: *Coluber petalarius* Linnaeus, *Coluber pethola* Lacépède, and *Coluber annulatus* Linnaeus. The earliest fixation of type appears to be that of Fitzinger (1843:27), who chose "*Oxyrrhopus pethola* Wagler," which is *Coluber pethola* Lacépède = *Coluber pethola* Linnaeus = *Coluber petola* Linnaeus = *Coluber petolarius* Linnaeus. Several other citations of type nominal species for the genus in the literature (e.g., of *Coluber petalarius* Linnaeus by Smith and Taylor, 1945:103; *Coluber petola* Linnaeus by Stuart, 1963:109, and by Bailey, 1970:229, who stated however that that name was not cited by Wagler; *Coluber petolarius* by Roze, 1966:194) are thus in technical error although the species in nature is the same in all.

The common name for this species is derived from the Spanish name Coral Falsa Indiana, applied to it by Roze (1970:95).

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UPWELLING ECOSYSTEMS AND THE OFFSHORE DISTRIBUTION OF MARINE TURTLES IN THE GALAPAGOS ARCHIPELAGO

Floyd E. Hayes and William S. Baker

Abstract

The offshore distribution of marine turtles within the Galapagos Archipelago was studied from ships during the austral winter of 1984. A substantial proportion of turtles were observed west of Isabela Island in an area characterized by cool upwelled water. This area, where other studies have correlated high concentrations of phytoplankton and other organisms with upwelled water, appears to be a major feeding area for marine turtles.

The marine turtles of the Galapagos Islands have been the subject of extensive investigations during the past 15 years (see reviews by Green, 1981, 1984a; Green and Ortiz-Crespo, 1982). These studies have focused primarily on the reproductive biology, population size, feeding habits and migration of green turtles, *Chelonia mydas agassizii*. Although Green (1984b) discussed the influence of Tropical Eastern Pacific currents on the long-distance movements of Galapagos green turtles, there is a paucity of information regarding the influence of oceanographic processes on the distribution of marine turtles within the archipelago. In this paper we report our observations on the offshore distribution of marine turtles during the austral winter of 1984.

Study Area

The oceanographic processes within the Galapagos Archipelago are complex, and have attracted the attention of both physical and biological oceanographers. The areas surrounding these islands are highly productive and characterized by oceanic fronts, strong current shear and patches of cool upwelled water. Upwelling from the Equatorial Undercurrent or Cromwell Current occurs in many areas of the Archipelago, but is most prominent in the regions surrounding Fernandina Island and to the west and north of Isabela Island (Wooster and Hedgpeth, 1966; Pak and Zaneveld, 1973; Houvenaghel, 1978). Minor areas of upwelling occur just off the coast of several islands (Houvenaghel, 1978).

In general the undercurrent flows both north and south in a curving pattern through the islands, and is characterized by relatively cool temperatures and an increase in biological productivity. Its maximum extension occurs during June through August, but may be altered by the El Niño current during some years.

Methods

From 15 June to 27 July 1984 we spent 60.83 hours censusing marine turtles from the decks of *Valiant* and *Acuario*. Visibility during the census varied from 200 m to 30 km, but was usually 15 km. Winds were usually southeasterly, 0-30 km/h, and seaswell was usually less than 1 m, but occasionally reached as high as 2 m. Water temperatures varied, but appeared to be normal for the season (Gemmill, 1984). The speed of the ships averaged approximately 11 km/h, and turtles were censused during approximately 676 of the 801 km traveled.

Harris (1969) divided the Galapagos Archipelago into five distinctive ecological zones based on oceanic and atmospheric conditions. We have slightly modified these zones to facilitate comparison between four different regions within the archipelago (Figure 1). We did not census turtles in zone 5.

Results

We observed 27 marine turtles during our cruise, an average of 0.44 per hour or 0.04 per km. Although our sample size was small, a substantial proportion of turtles were found in region 3 (Chi-square, $df = 3$, $p < .001$; see Table 1), in the western part of the archipelago, where upwelling was most prominent. Most of these turtles were seen within one km of the northwestern coast of Isabela Island (Figure 1). We did not attempt to identify the turtles since most submerged quickly after our initial sightings.

Table 1. Comparative distribution of marine turtles in zones 1-4.

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
Hours of observation	24.00	8.42	13.58	14.83
Number of turtles observed	2	0	23	2
Number of turtles per hour	0.08	0.00	1.69	0.14

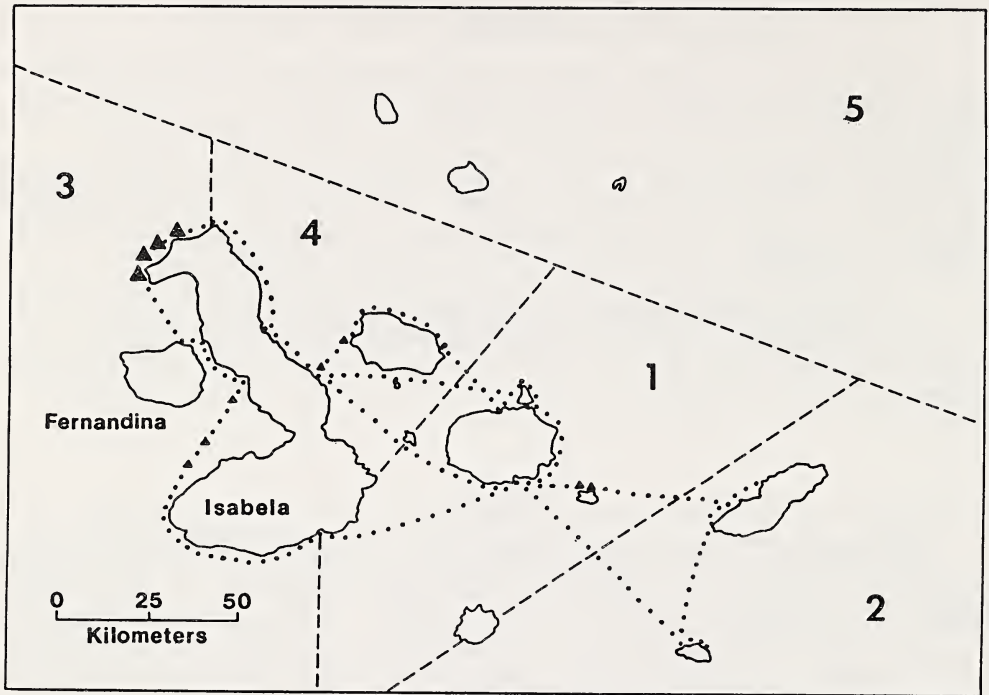


Figure 1. Map of the Galapagos Islands. Dashed lines represent borders of ecological zones based on Harris (1969); dotted lines indicate routes traveled. Small triangles indicate sightings of single turtles, and large triangles represent sightings of five turtles.

Discussion

Upwelling areas are extremely important in the ecosystems of marine organisms because they supply 50% of the world's sea food (Packard, 1981). In the Galapagos Islands, several studies have demonstrated the high biological productivity of upwelled water. Maxwell (1974) and Jimenez (1979) showed that the highest values of primary production and chlorophyll content occurred on the western side of the archipelago, and the concentrations of numerous phytoplankton species were reported by Jimenez (1981) to be highest just west of Isabela Island, especially in Elizabeth Bay. Arcos (1981) found a similar pattern in the distribution of the copepod *Acartia levequei*, and Hayes and Baker (MS) found that several species of seabirds were most abundant in areas where upwelling occurs.

Green and Ortiz-Crespo (1982) and Green (1984a,b) inferred that, based upon the large numbers of turtles observed, the algae beds in the Elizabeth Bay area along the western coast of Isabela Island and east of Fernandina Island appeared to be a major feeding area for marine turtles. Because green turtles in the Galapagos feed on over 30 species of algae (Green, 1984a), it is not surprising that these turtles are most abundant in areas where primary productivity is greatest. Since Green (1984a) indicated that the majority of turtles feeding in the Elizabeth Bay area are residents rather than migrants, we suggest that the offshore distribution of marine turtles could be used as a rough indicator of upwelled Equatorial Undercurrent water.

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TERMINOLOGY OF REPRODUCTIVE PARITIES

Three terms have long been used to denote reproductive modalities of tetrapod vertebrates: oviparity, ovoviviparity, and viviparity. Oviparity has been accepted to refer to egg-laying, viviparity to live-bearing, and ovoviviparity to egg-retention to the hatching stage. The latter condition thus has been envisioned as simulating viviparity simply through holding the eggs in the body of an adult (usually the female) until they hatch, whereas in viviparity at least some of the adaptations for independent development are lost.

As pointed out by Shine (1985) and Yaron (1985), the diversity of reproductive parities among vertebrates is so great, and the history of concepts of ovoviviparity so varied, that the latter term has lost its utility through imprecise or erroneous concepts it has conveyed. Thus only two major categories of vertebrate reproductive parities are tenable: oviparity and viviparity.

However, subcategories of each of these major categories merit recognition. *Euviviparity* is the only term commonly accepted, applied to a division of viviparity characterized by major nutritional dependence of the embryo upon the adult, mediated by a placenta (in turn defined as a structure composed of both embryonic and oviductal tissues specifically adapted for exchange of metabolic essentials and products).

Oviparity itself requires a rather broad definition in reference to both amphibians and reptiles, and to vertebrates in general. Eggs are laid in all, to be sure, but a shell may (some fishes, all egg-laying reptiles) or may not (most fishes, all egg-laying amphibians) be present. The critical attribute of oviparity is complete independence of embryonic development from continued parental (or other adult) input, at least in late stages.

Recognition of two major subcategories of oviparity is important in phylogenetic contexts, in spite of the spectral continuity between them. *Euoviparity* may be regarded as egg-deposition in early stages of development, *metoviparity* as egg-deposition in late stages of development ("egg-retention"). Most oviparous vertebrates are euoviparous, laying their eggs in early developmental stages. Some reptiles, on the contrary, retain the eggs *in utero* for considerable periods, so that postdepositional development may vary from a few days to a few weeks, as opposed to the several-month period required by euoviparous eggs. Metoviparity is a condition from which viviparity clearly has evolved in virtually all, if not all, viviparous reptiles, but not all vertebrate viviparity is of that source.

Viviparity itself has to be defined as the converse of oviparity: that is, it entails complete dependence of embryonic development upon continued parental (or other adult) input, in all stages. In all reptiles, that dependence occurs *in utero*, but in amphibians the dependence may involve

most bizarre organs--the skin, buccal membrane or stomach wall of one parent or the other, where placental analogs (best termed *pseudoplacentae*, as opposed to *euplacentae*), characteristically develop. Viviparity of such bizarre types may be termed *xenoviviparity*, occurring in most viviparous amphibians and a few fishes. All such cases obviously evolved from euoviparity, never from metoviviparity.

Uterine viviparity (*meroviviparity*) occurs in some fishes, a few amphibians, and in all viviparous reptiles and mammals. Yet even among these vertebrates, it is useful to distinguish two types: *euviviparity*, limited to extant mammals (with a complete or nearly complete loss of a yolk source of nutrition), and *protoviviparity*, occurring in all other meroviviparous vertebrates (with large yolk resources for the embryo).

The categories of reproductive parities in vertebrates can thus be summarized as follows:

- oviparity (egg-laying)
 - euoviparity (early deposition)
 - metoviviparity (late deposition; egg retention)
- viviparity (live-bearing)
 - xenoviviparity (from euoviparity, with pseudoplacentae)
 - meroviviparity (from metoviviparity, with euplacentae)
 - protoviviparity (with large yolk resource)
 - euviviparity (with little or no yolk resource)

Numerous examples of these categories for amphibians are cited in Duellman and Trueb (1985), and for reptiles in Shine (1985) and Yaron (1985).

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THE GENERIC ALLOCATION OF TWO SPECIES
OF MEXICAN ANGUID LIZARDS

In announcing the discovery of a remarkable new species of anguid lizard from Nuevo León, Mexico, Knight and Scudday (1985) refrained from involvement in the controversy over the validity of the genera *Barisia* and *Elgaria*, partitioned from the genus *Gerrhonotus* sensu lato particularly by Waddick and Smith (1974). In part their decision was predicated upon a perceived close relationship between their new species, *Gerrhonotus parvus*, and McCoy's (1970) *Gerrhonotus lugoi*, and the absence of documentation by Waddick and Smith for their allocation of *G. lugoi* to the genus *Barisia*. The purpose of the present article is to justify allocation of the latter species to *Barisia*, and *G. parvus* to *Elgaria*.

The analysis of scale characters by Waddick and Smith gives the most recent summary of the generic distinctions (1974:266) between the three genera *Gerrhonotus*, *Elgaria* and *Barisia*. Seven characters of the head scales were the only features determined to correlate well generically. Not mentioned there, because the review was confined to scale characters, is one other feature of major importance in distinction of the three genera: type of reproductive parity, with *Gerrhonotus* being oviparous, *Barisia* viviparous, and *Elgaria* both viviparous (only the northernmost species *caerulea*) and oviparous.

In relation to these characters, the states exhibited by *parvus* are uniformly consistent with those of *Elgaria* (excluding number of anterior gulars, not recorded for either *lugoi* or *parvus*): no postrostral, nasal contacting rostral, cantholoreal present, no anterior internasals, supranasals in contact, oviparous. On the contrary, in *Gerrhonotus* sensu stricto (that is, only *G. liocephalus* and its subspecies), the postrostral is seldom absent, the nasal rarely contacts the rostral, the cantholoreal is seldom present, the anterior internasals are always present but never in contact, and the supranasals are never in contact. It is, like *parvus*, oviparous, but that is the only generic character in agreement.

G. parvus differs from *Barisia* in having the nasal contacting the rostral, in lacking anterior internasals, in having the supranasals in contact, and in being oviparous (in *Barisia*, the nasal rarely contacts the rostral, the anterior nasals are rarely not present, and usually in contact when present, the supranasals are rarely in contact, and it is always viviparous).

Hence there is no question that *G. parvus* belongs to the genus *Elgaria*, and should be known as *E. parva*. It is the only species of the genus known to occur in the Atlantic drainage system; all others are limited to western Mexico and United States.

Although *E. parva* possesses a number of features similar to those of *G. lugoi*, the important generic characters are not among them. The two species are geographically proximate, but *lugoi* has no naso-rostral contact, no contact of the supranasals, and does have anterior internasals in contact medially; its parity type is unknown. In all these features it differs from *Elgaria*. It likewise differs from *Gerrhonotus sensu stricto* in lacking a postrostral, having a cantholoreal and in having the anterior internasals in medial contact. In every respect, so far as known (parity type and number of anterior gulars unknown), *G. lugoi* conforms with the generic characters of *Barisia*, and differs from *Elgaria* and *Gerrhonotus* exactly as *Barisia* does. Hence it is logical to place it in the latter genus, where it should be known as *Barisia lugoi*.

Although the generic allocation of *B. lugoi* is clear on the basis of known character states, it is not by any means certain that the species is viviparous, as are all other species of that genus. Were the species of high altitude, as are all other members of the genus, little doubt would be entertained that it is viviparous, even though the oviparous *G. liocephalus* occurs more widely at high altitudes than at low. But *B. lugoi* is from a relatively low altitude (740-800m) in semixerix environs, where oviparity might be expected to be at least the rule. Although *B. imbricata* and *B. levicollis* occur equally far north, both are montane species. Thus an unequivocal generic allocation of *B. lugoi* awaits more information on parity type. If it proves to be oviparous, the tenability of both *Barisia* and *Elgaria* will be open to question, even as subgenera. Isozyme and other chemotaxonomic data may well be required to establish definitively the status of these nominal gerrhonotine taxa.

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MATING BEHAVIOUR OF THE MOUNTAIN LIZARD

*Sceloporus scalaris*Abstract

The mating behaviour of *Sceloporus scalaris* was observed 9 times in the field, at "La Michilia" Biosphere Reserve, Mexico. Movements and attitudes of the female and male during the mating process are described. Our observations are in agreement with those reported for other species of iguanids.

Sceloporus scalaris Wiegmann (Sauria: Iguanidae), is an oviparous lizard characteristic of the open grasslands of Mexico, especially those situated at very high elevations. Although it has a wide distribution and is quite abundant, very little is known about its general behaviour (Anderson, 1962), and nothing concerning mating behaviour.

As part of a general study of the dynamics of this species, and the behaviour of the individuals, we made 8-hour daily observations in the field over 10 consecutive days of every month, for one year (1981). The study area comprised of a grid measuring 1 ha. in "La Michilia" Biosphere Reserve, State of Durango, Mexico (23°25'N - 104°16'W).

In the first half of May, 1981, copulation was recorded 9 times. The basic pattern of mating behaviour can be summarized as follows:

As the male approaches the female, he first maintains a distance of 0.75 to 1.20m, where he executes rhythmic up and down movements with the head, and slow push-ups lifting his body in a horizontal plane. These movements only last for a few seconds (20 to 35), and are followed by a quick approach to the female, nodding his head at the same time. If the female is not receptive, she moves away; otherwise she stays still, allowing the male to approach.

When the male is in close proximity to the female and intends to hold her, she always tries to run away. The male then chases her until he can grab her tail or hind legs with his mouth. Then, keeping her immobile, he will execute a series of very fast movements in order to change his position in relation to the female's body. He now holds her with his mouth by the neck or shoulder skin and embraces her with his front legs. At this point the female tries to escape and, due to his strong hold they both roll over several times. The male locates his tail under the female in such a way that both cloacas are in contact allowing intromission to take place. They hold this position for approximately 90 to 180 seconds, followed by the male's pelvic movements lasting 4 to 16 seconds; the female keeps still throughout, in a position similar to the submissive posture, but with her head up and tail lashing.

This posture is maintained for 120 to 190 seconds, until the male relaxes his bite and the female liberates herself from the lock position and runs away. Sometimes the male follows her but not very persistently. He usually remains still, keeping his head in an upright position for about 3 minutes before moving away. Frequently the male was observed to drag his caudal region.

The average time for mating in *Sceloporus scalaris* is approximately 26 minutes, from when the male approaches the female for the first time, until the female runs away from him after copulation.

It is of interest that during mating this species can become an easy prey for potential predators, as it takes place in open areas.

Our observations are in accordance with those reported for other species of Iguanids (Burkholder and Tanner, 1975; Carpenter, 1961, 1980) reaffirming, therefore, that the mating pattern throughout this family is highly stereotyped (Carpenter and Ferguson, 1977).

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THE HISTOCHEMISTRY OF THE LINGUAL
SALIVARY GLANDS OF THE LIZARD
Acanthodactylus schmidtii (WIEGMANN)
(REPTILIA, LACERTILIA, LACERTIDAE)*

Noory T. Taib and Bashir M. Jarrar

Abstract

The lingual salivary glands of *Acanthodactylus schmidtii* were investigated histochemically and were observed to secrete and elaborate neutral mucosubstances, sialidase labile carboxylated mucosubstances and hyaluronidase resistant sulfomucins but no glycoproteins. These results are discussed in the context of the feeding habits and phylogeny of reptiles.

Introduction

Histochemical studies on lingual salivary glands of vertebrates are mainly concerned with mammals while little attention is being paid to the lingual glands of non-mammalian vertebrates. Few studies have been carried on the lingual salivary glands of turtles (Carmignani and Zacccone, 1975; Nalvade and Varute, 1976; Taib and Jarrar, 1985a) and some lizards (Raynaud, 1961; Gabe and St. Girons, 1969; Taib and Jarrar, 1985b,c).

In the present study, histochemical characterization of the lingual salivary glands of the diurnal, insectivorous lizard, *Acanthodactylus schmidtii* (Wiegmann) was undertaken.

Materials and Methods

Fifteen adult, male and female *Acanthodactylus schmidtii*, 12.5-16.7 cm in length and 8.75-24.35 gm in weight were trapped from Riyadh Region, Saudi Arabia. They were killed by etherization and the whole tongue was removed from each animal and quickly immersed in cold (4°C) 2% calcium acetate in 10% buffered formalin (pH 7.0) and alcohol fixatives for 24 hrs. They were then thoroughly washed in running water, processed for sectioning at 4-5 µm thickness and the sections were stained with haematoxylin-eosin Masson trichrome stain for histological examination. Paraffin, as well as unfixed frozen sections were then utilized in the following histochemical reactions.

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Neutral Mucosubstances: Periodic and Schiff (PAS) technique (Gurr, 1962), PAS after diastase digestion (McManus and Mowry, 1964), PAS after α -amylase digestion (Luna, 1968), PAS after acetylation blockade (McManus and Cason, 1968), PAS after acetylation-saponification (Ozello et al., 1958), PAS after phenylhydrazine treatment (Spicer et al., 1967) and PAS after treatment with chloroform and methanol.

Acid mucosubstances: Alcian blue (AB) at pH 2.5, 1.0, and 0.4 (Mowry, 1956; Luna, 1968).

Distinction between acidic and neutral mucosubstances: AB(pH 2.5)-PAS (Mowry and Winkler, 1956) and AB(pH 1.0)-PAS (Spicer et al., 1967).

Distinction between sulfomucins and sialomucins: Aldehyde fuchsin (AF) and AF-AB, pH 2.5 (Spicer and Meyer, 1960); weak (25°C, 16 hr), mild (37°C, 4 hr) and strong (60°C, 4 hr) methylation-saponification-AB, pH 2.5 (Quintarelli et al., 1961); acid hydrolysis (0.1N HCl, 60°C, 4 hr)-AB(pH 2.5) (Spicer et al., 1967); toluidine blue (TB) buffered at pH 1.7 and 3.4 (Landsmeer, 1953); Critical electrolyte concentration (CEC) technique for extinction of alcianophilia at pH 5.6 in the presence of gradual concentration of Mg^{++} (Scott and Dorling, 1965). Sections of the lingual glands of the lizard *Uromastix microlepis* were used as controls for sialomucins (Taib and Jarrar, 1985b) and the mast cells population in the tongue of the species under study were used as controls for sulfomucins.

Enzymes digestion tests: Diastase-PAS technique (McManus and Mowry, 1964); neuraminidase (Sialidase, *Vibrio cholerae*, type V)-AB(pH 2.5) (Spicer and Warren, 1960); hyaluronidase (testicular)-AB(pH 2.5) (Spicer et al., 1967). Neuraminidase-TB(pH 3.7); hyaluronidase-TB(pH 2.0) (Pearse, 1972). Control sections were incubated in the buffer solutions alone without the enzyme.

Proteins: Mercuric bromophenol blue method (Mazia et al., 1953); ninhydrin-Schiff (Yasuma and Itchikawa, 1953), chloramine-T-Schiff (Pearse, 1972).

Photographs were taken with a 35 mm. Zeiss Ikon camera on kodacolor NR 100 film.

Results

The tongue of *A. schmidtii* is lined with backward pointing filiform papillae in the dorsal epithelium. The lingual glands comprise goblet cells occurring in the papillar invaginations of the posterior third of the dorsal surface and the lateral sides of the tongue (Fig. 1); other parts of the organ are almost devoid of any glandular structure. Goblet cells gradually increase inside the crypts towards the larynx area where they become larger and more closely packed. A well developed forward-pointing fold containing mainly mucous cells is found at the most posterior part of the dorsum. The glands cells have flattened, basally located nuclei with clear apical ends and are surrounded by a delicate basement membrane.

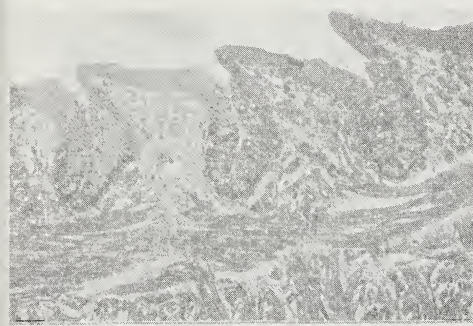


Fig.1



Fig.2

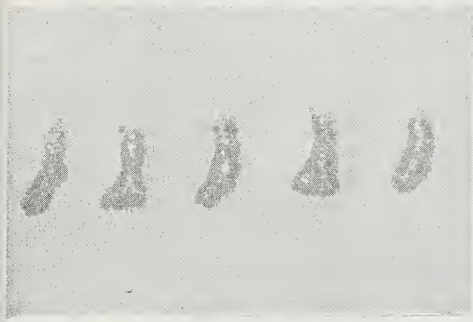


Fig.3

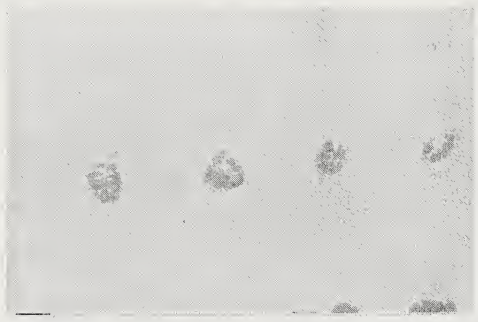


Fig.4

- Fig. 1 Lingual glands of *A. schmidtii* after staining with haematoxylin-eosin. X800.
- Fig. 2 Lingual glands of *A. schmidtii* after staining with PAS. X420.
- Fig. 3 Lingual glands of *A. schmidtii* after staining with AB(pH 2.5). X420.
- Fig. 4 Lingual glands of *A. schmidtii* after staining with AB(pH 1.0). X370.

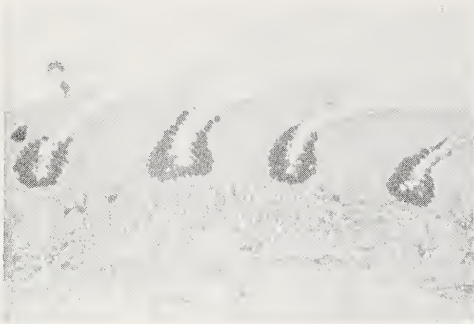


Fig.5



Fig.6

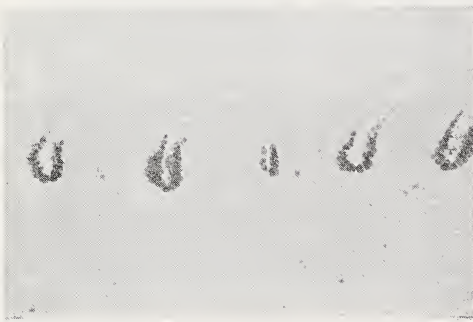


Fig.7

Fig. 5 Lingual glands of *A. schmidtii* after staining with AB(pH 1.0)-PAS. X370.

Fig. 6 Lingual glands of *A. schmidtii* after staining with AF. X450.

Fig. 7 Lingual glands of *A. schmidtii* after staining with AB(pH 2.5). X370.

Table 1. The histochemical reactions in the lingual salivary glands of *Acanthodaetylus schmidtii*.

<u>Histochemical Reaction</u>	<u>Results</u>
PAS	+++ ,P
Diastase digestion-PAS	Nb;+++P
α -amylase-PAS	Nb;+++P
Acetylation-PAS	Cb
Acetylation-deacetylation-PAS	+,P
Phenylhydrazine-PAS	Nb;+++P
AB (pH 0.4)	+ $\pm$,B
AB (pH 1.0)	+++ ,B
AB (pH 2.5)	+++ ,B
AB (pH 1.0)-PAS	++ ,BP
AB (PH 2.5)-PAS	++ ,BP
AF	++ ,P
AF-(AB pH 1.0)	++ ,Bp,B,P
AF-(AB pH 2.5)	++ ,BP,B,P
Acid hydrolysis-AB (pH 2.5)	$\pm$,B,Pb
W. methylation-AB (2.5)	$\pm$,Pb
W. methylation-saponification-AB (pH 2.5)	+ $\pm$,B
M. methylation-AB (pH 2.5)	$\pm$,Pb
M. methylation-saponification-AB (pH 2.5)	+,B
S. methylation-AB (pH 2.5)	Cb
S. methylation-saponification-AB (pH 2.5)	$\pm$,B
TB (pH 1.7)	$\pm$
TB (pH 3.4)	+
CEC (AB, 0.1 M)	+ $\pm$,B
CEC (AB, 0.2 M)	++ ,B
CEC (AB, 0.4 M)	+,B
CEC (AB, 0.5 M)	$\pm$,B
CEC (AB, 0.6 M)	-
Neuraminidase-AB (pH 2.5)	++ ,Pb
Neuraminidase-TB (pH 3.7)	Pb;+B
Hyaluronidase-AB (pH 2.5)	Nb,+++B
Hyaluronidase-TB (pH 2.0)	Nb; $\pm$,B
Ninhydrin-Schiff	-
Hg-bromophenol blue	-
Chloramine T-Schiff	-
Trypsin digestion-PAS	Nb;+++ ,P
(Chloroform + methanol)-PAS	Nb;+++ ,P

 Reactions: -, negative; $\pm$, very weak; +, feeble; ++, moderate; +++ , intensely positive; Cb, complete blocking; M, mild; Pb, partial blockade; Nb, no blockade; S, strong; TB, toluidine blue; W, weak.

Colours: B, blue; Bp, bluish purple; P, pink.

Table 1 summarizes the results of histochemical reactions of these glands which exhibit strong PAS reactivity (Fig. 2), neither labile to α -amylase nor to saliva digestion or to prior phenylhydrazine treatment. This reactivity is completely blocked by acetylation but is partly restored by deacetylation-PAS sequential techniques. The mucous cells of the glands exhibit marked alcianophilia at pH 2.5 and 1.0 but to lesser extent at pH 0.4 (Figs. 3 & 4). The glands react with both PAS and AB and stain bluish purple with AB(2.5)-PAS and AB(1.0)-PAS (Fig. 5). The glands react with AF (Fig. 6) as well as with AF-AB(2.5) and AF-AB(1.0). The alcianophilia of the glands is partly lost at pH 2.5 with acid hydrolysis and weak methylation and thereafter restored by saponification techniques. The glands react moderately with critical electrolyte concentration technique at 0.1M $MgCl_2$ and more intense colour is obtained at 0.2M $MgCl_2$ up to 0.6M where the complete disappearance of alcianophilia. Metachromatic reaction was observed with buffered toluidine blue at pH 1.7 and 4.5, but neither the alcianophilia at pH 1.0, nor the metachromatic at pH 2.0 were affected by hyaluronidase digestion. However, both at, respectively, pH 2.5 and pH 3.7 were partially lost by neuraminidase digestion. Moreover, these glands reacted negatively with ninhydrin-Schiff, mercuric bromophenol blue and chloreamine-T Schiff for protein detection and no sexual dimorphism was observed in their secretions.

Discussion

The lingual glands are entirely absent from the Varanidae, Amphisbaenia, Ophidia and some species of Chelonia such as *Chelonia mydas* (Kochva, 1978). On the other hand, there is great diversity both in morphology and reactivity of these glands in the reptiles that have them extending from primitive glands with three types of goblet cells (similar to those in fishes) as in the terrapin, *Mauremys caspica* (Taib and Jarrar, 1985a) through goblet cells and simple tubular glands of the turtle *Pseudemys scripta* (Carmignani and Zaccane, 1975) to more developed glands in lizards (Raynaud, 1961; Dornesco and Andri, 1966; Gabe and ST. Girons, 1969; Taib and Jarrar, 1985b,c). The lingual glands of lizards vary from mucous cells together with simple tubular structures as in *Anguis fragilis*, *Eremias arguta*, *Ablepharus kilaibeli* and *Scincus mitranus* (Raynaud, 1961; Dornesco and Andri, 1966; Taib, 1985) to only simple tubular ones as in *Agama blandfordi* and to tubulo-alveolar in *Uromastix microlepis* (Taib and Jarrar, 1985b,c). However the lingual glands of *A. schmidtii*, seen in the present study, seem to be amongst the most primitive in lizards.

A tentative interpretation of the types of mucosubstances in the lingual secretion of *A. schmidtii* can be made from the results of different histochemical reactions used in the present study and from the classification of mucosubstances proposed by Mowry and Winkler (1956), Spicer and Meyer (1960), Scott and Dorling (1965), Pearse (1972). Accordingly, the lingual salivary glands of *A. schmidtii* secrete and elaborate neutral mucosubstances, sialidase labile carboxylated mucosubstances and hyaluronidase resistant sulfated mucosubstances while glycoproteins are absent from their secretions. A variable histochemical characterization of the lingual salivary glands are obtained among different species within a given order of reptiles. Neutral

mucosubstances, sialomucins as well as sulfomucins were identified in the glandular secretions of the terrapin *Mauremys caspica* (Taib and Jarrar, 1985a) and the fresh water turtle *Geoemyda trijuga*, but the later species showed hyaluronic acid and/or chondriotin sulfate A and C (Nalvade and varute, 1976). On the other hand, Carmignani and Zaccone (1975) have reported the existence of sialoglycoproteins as well as hyaluronidase resistant sulfomucins in the glandular secretion of the turtle *Pseudemys scripta*. The lingual glands are mucous in Gekkonidae, Xantusiidae, mucoserous in Sphenodontidae, Anguidae and Pygopodidae, but seromucous in Chamaleonidae and typically serous in some species of Iguanidae and Agamidae (Gabe and ST. Girons, 1969).

The structure and secretions of the lingual glands of the purely insectivorous lizard, *A. schmidtii* observed in the present study are, however, different from those of other insectivorous lizards, such as *Agama blandfordi* that has mucous cells in the posterior portion of the tongue which synthesize neutral mucosubstances and sialomucins but no sulfomucins (Taib and Jarrar, 1985c) and from those of *Tupinambis teguixin* whose glands comprise mucous cells that secrete only mucosubstances and sialic acid (Lopes et al., 1974). They also differ, but only in structure from those of the herbivorous lizard *U. microlepis* that has tubulo-alveolar glands with the same type of secretion (Taib and Jarrar, 1985b).

The significance of the histochemical diversity, as well as, the morphology and histological variations in the lingual salivary glands of the various reptiles is not fully understood, but might imply phylogenetic relationships and/or different feeding habits of these animals, a point to be investigated.

Acknowledgements

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OBSERVATIONS ON THE DISTRIBUTION AND BIOLOGY OF SOME YUCATAN PENINSULA AMPHIBIANS AND REPTILES

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Abstract

Few distributional records of the herpetofauna are available for the western fourth of the Mexican section of the Yucatan Peninsula. New records are presented for 36 species, several being from mesophytic hammocks that are surrounded by mangrove swamps. Natural history data and morphological variations are given for many species and discussion of systematics problems is presented for *Rana berlandieri*, *Elaphe flavirufa*, and *Micrurus diastema*.

The appearance of Lee's (1980) study on the ecological geography of the Yucatan Peninsula provided a recent look at a much neglected region of México. The states of Campeche, Yucatán, and Quintana Roo that make up the peninsula have little altitudinal relief (270 m msl maximum), are almost entirely a limestone substrate, have few surface streams, and except where cleared constitute a dense scrub forest whose subdivisions are poorly defined (Lundell, 1934). The area on which our report is based is almost wholly within a single phytological region, Lundell's Northern Division, but much of the area has been denuded and turned into agricultural lands. Rainfall is a more notable variable of the northern part of the peninsula, ranging from 2000 mm in a small region of the extreme east to 600 mm or less in the northwest (Doehring and Butler, 1974).

Despite the homogeneity of northern Yucatán's ecogeography the region has a diverse herpetofauna that includes several endemics, some disjunct populations, and disjunctions of several genera. In his study Lee (1980) provided a comprehensive set of maps that show known localities for specimens that he collected, saw in museums, and that he could determine from the literature. Yet those maps are striking by the almost complete absence of records from the western 100 km of the peninsula from latitude 19° northward, and at latitude 20° N± there is a concentration of records to the east of that neglected coastal corridor. The difficulty of penetrating the dense, thorny forests precludes much effective collecting, and as a result the collections from the Yucatan Peninsula more nearly reflect places along roadways rather than actual distributions. Thus road collecting has been the most profitable way of sampling.

The many new distributional records presented herein are primarily the result of one of us (White) driving between sites while conducting plant ecology studies. Dundee, on the other hand, visited the western coastal fringe of the peninsula to assess feasibility of studying the herpetofauna of Los Petenes, a series of low, forested hummocks lying amid the mangrove swamps (Rico-Gray, 1982), and later visited the northwestern sections of the peninsula accompanied by Ernest A. Liner. Although a study of Los Petenes has not been undertaken, habitats and species observed there suggest that

many species not known from the western hiatus mentioned above may indeed occur across the peninsula. The mangrove swamps show strong, seasonally variable salinity (2.0-10.0 ppt in wet season, 70.0-90.0 ppt in dry season) and low salinity may persist in the early dry season because the flow of underground water from the higher interior continues to surface in the low coastal zone for some time after the rains cease. Thus we doubt that the mangrove region would be a hostile environment to amphibians and reptiles.

We wish to acknowledge the Mesoamerican Ecology Institute of Tulane University and the Tinker Foundation for supporting our field work in the Yucatan Peninsula.

Because the Yucatan Peninsula has distinct wet and dry seasons we include dates for all species noted so as to enhance knowledge of activity periods for the herpetofauna. Unquestionably some mysteries in the distributions of the animals are due to failure to search at appropriate times of the year. Some of the dates of collections, when correlated with the size of the animals taken, are instructive as to probable parturition times for various species.

To compare our localities to those shown in Lee's (1980) paper we used an opaque projector to enlarge his maps and superimposed these projections on a detailed map available to us. In the course of pinpointing our localities we discovered that the boundaries ascribed to the borders of Campeche, Yucatán, and Quintana Roo did not coincide with Lee's boundary lines. Apparently Lee's boundaries are correct (Dundee, 1985) so we compare our localities, which follow current National Geographic Society maps, to his. The National Geographic Society maps correspond to maps issued by the official Mexican agency (Dirección General de Geografía de Territorios Nacionales). Some published herpetofaunal locality records for Mexican states are unquestionably in error as to state designation. Most detailed maps for the peninsular states issued by commercial publishers use old, unofficial boundaries.

Caudata

Bolitoglossa yucatanana (Peters). Previous reports of this uncommon endemic species give the collection site as being near cenotes or caves. On 11 December 1983 Dundee found a live specimen sitting in a shallow dish of water alleged to contain some type of ant poison under the overhang of a stable roof 8 km N of Mérida, Yucatán. That date is within the dry season but a heavy rain had occurred several days earlier. Although the stable and adjacent riding area were rather barren, a dense, low, second growth woodland is located several hundred meters to the west. We suspect that *Bolitoglossa yucatanana* may be widespread in wooded areas of the peninsula, but evades detection because it emerges to the surface only during the wet season and is difficult to reach because of the almost impenetrable nature of the thorny woodlands. The locality is at the extreme northwestern edge of the range near three of the previously known six localities.

The specimen (Tulane 19781), a female, measures 71 mm TL and 42 mm SV, and has 12 costal grooves, with 3.5 costal grooves between the adpressed toes. The oviducts are small and the ova small and unyolked, suggesting that the animal is immature.

Anura

Bufo marinus (Linnaeus). Specimens from 20.1 km W Bella Flor and 18.4 km N Chunchucmil, Yucatán, found 28 October 1984 by Dundee and Liner and deposited at the Museo de Historia Natural de la Ciudad de México in Mexico City, extend the range about 40 km westward into the long N-S coastal section from the northern coast of the peninsula to southern Campeche, for which no records exist.

Bufo v. valliceps Wiegmann. Tulane 19812 from 20.1 km W Bella Flor and TU 19813 from 18.4 km N Chunchucmil, Yucatán, taken by Dundee and Liner 28 October 1984 pushes the known range 20 km east of the coast and into a gap from Celestún to Mérida where the species had not previously been found.

Hypopachus variolosus (Cope). Tulane 19815 from 12 km N Chunchucmil, Yucatán and TU 19821-19822 from 13.8 km N Chunchucmil, taken at night on a road after a rain, extend the range about 28 km SW into a large range gap that parallels the western coast to well south into southern Campeche state.

Leptodactylus labialis (Cope). Many examples were seen by Dundee and Liner on the road at night after a rain 28 October 1984 from 13.8 to 22.5 km N Chunchucmil, Yucatán (TU 19810, 19816-19820). These localities are 30± 5 km SW of known records and extend the range into the long coastal strip gap that extends into southern Campeche state.

Phrynohyas venulosus (Cope). A single specimen found hopping on a road 13.8 km N Chunchucmil, Yucatán at night after a rain by Dundee and Liner is a 12.5 km southward range extension into a sizeable gap surrounded by known records.

Rana berlandieri Baird. This frog was seen in substantial numbers by Dundee and Liner on the roads and around pools from 20 km W Bella Flor, and from 13.8 to 22.5 km N Chunchucmil, Yucatán on 28 October 1984. These localities are generally 50 km SW of known records and thus extend the range into the poorly known western coastal area. Sanders (1973) described a new race, *Rana berlandieri brownorum*, from southern Campeche and southeastern Vera Cruz and projected that that race extended to Yucatán. Although our specimens had the strong bronze dorsal coloration ascribed to *brownorum*, they did not possess the keeled linear spots that characterize that form. Leopard frogs, under the name *Rana pipiens*, were depicted in many Yucatecan localities by Lee (1980). Sanders used only material from Vera Cruz and Campeche for his description of *brownorum* and apparently did not look at material other than *R. b. forreri* and *R. b. berlandieri* from areas west and north of his *brownorum* sites. This was unfortunate, for at that time there were leopard frogs with definite Yucatan Peninsula localities available

(Duellman, 1965; Gaige, 1936; Smith, 1938). Henderson and Hoevers (1975) did use the name *Rana berlandieri* for the leopard frogs of Belize. Our Yucatán specimens were deposited at the Museo de Historia Natural de la Ciudad de México, but a color slide made by Liner using daylight illumination shows that the bronze color is not evident, at least not in that specimen - or perhaps because bronze color is manifested only at night.

Inasmuch as the dorsal pattern in our specimens strongly resembles conventional *Rana berlandieri*, we herein apply that name to them. Hillis, Frost, and Wright (1983) used the name *R. brownorum* for Sanders' animals, an allocation based on morphology, not on biochemical characteristics that were the thrust of their cladistic scheme. Frost (1982) had commented on the distinctive appearance of the type series of *brownorum* but considered the subspecific designation useful at that time; he also established *R. b. forreri* as a full species, *R. forreri*. The systematics of Yucatan Peninsula leopard frogs thus remains a topic for detailed investigation and the use of trinomials is questionable at this time.

Testudines

Kinosternon scorpioides cruentatum (D,B, and D). A specimen (Tulane 19782) taken on 10 December 1983 on the road 1 km W El Remate in the extreme northern tip of Campeche extends the known distribution 80 km westward.

The collection site is actually in a mangrove swamp, but a large limestone spring that emerges at El Remate sends a stream 2-3 meters wide and perhaps a meter deep well into the swamp and alongside the road. The stream, as judged by its vegetation, remains freshwater (in October 1984 its salinity was measured to be 1.3 ppt) and probably is the main habitat. The roadbed extends the area in which the turtles probably are able to deposit their eggs. White saw another specimen in the same general location in mid-January 1984.

Rhinoclemmys areolata (D,B, and D). A specimen documented by a color slide was seen 5 km S Muna, Yucatan 25 September 1982 and represents a 9 km westward range extension.

Crocodylia

Crocodylus moreleti D,B, and D. Dundee's trip to Los Petenes was accomplished with the guidance of Marco A. Lazcano B., a biologist with the Instituto Nacional de Investigaciones Sobre Recursos Bióticos, who is studying Morelet's crocodile. Lazcano tried to find a living animal that he had seen on occasion at a limestone spring at El Remate, extreme northern Campeche, but was unsuccessful, probably because the animals are very shy by day. He reports that they also inhabit the stream formed by the spring.

The El Remate site is 144 km SW and 210 km NNE of previous records and probably is indicative that this crocodile may extend all along western coastal Yucatan.

Sauria

Ameiva undulata gaigeae Smith and Lafe. A DOR specimen (Tulane 19809) found by Dundee and Liner 27 October 1984 8.8 km W Bella Flor, Yucatán extends the range 40 km W and 30 km S of previous reports. Numerous other teiids seen running across the road between Mérida and Celestún may have been this species.

Basiliscus vittatus Wiegmann. Many juveniles were seen along the road leading from El Remate in extreme northern Campeche to points 3 km W and 2 km N of El Remate on 10 December 1983, 57 km W of known localities. The habitats at the sites remote from El Remate are low mangrove swamps. We assume that the raised petenes probably are the area where the eggs are deposited but the roadbed now creates additional and perhaps more secure burial sites for the eggs. Marco A. Lazcano B. (see *Crocodylus moreleti* account) stated that he had seen many adults along the road but did not recall if it was in the dry or wet season.

Ctenosaura similis (Gray). A live one seen by Dundee and Liner 16.8 km E Celestún and a DOR specimen seen 3.7 km SW Kinchil, both in Yucatán, fill in a gap between Celestún and Mérida. Rocky terrain is infrequent in the western fourth of the peninsula, thus the species is uncommon there.

Enyaliosaurus defensor (Cope). A specimen (Tulane 19768) taken 27 September 1982 in a forest 1 km S Calcehtok, Yucatán extends the range 46 km southwestward.

Sceloporus chrysostictus Cope. This species was encountered by Dundee and Liner at Bella Flor and 3.7 km SW Kinchil (TU 19808), Yucatán. These animals merely add inland records midway between Mérida and Celestún in the poorly known western part of the peninsula.

Serpentes

Boa constrictor imperator Daudin. A specimen from 3 km south of Cooperativa, Yucatán, taken 23 February 1982 and documented by a color slide does not extend the known range but does fill in a large gap, being 31 km S and 94 km NNE from previous records. A DOR specimen seen by Dundee and Liner 1.2 km SW Kinchil, Yucatán fills in a distributional gap west of Mérida. White reports seeing many other specimens DOR. Two juveniles (Tulane 19795-19796) from between Santa Elena and the Uxmal ruins in Yucatán, taken 10 and 12 July 1982, give some idea of time of birth of this species; both had yolk evident in the gut. Their lengths were 459 and 476 mm BL and 515 and 545 mm TL.

At the more northerly latitude of Sinaloa state, México, Hardy and McDiarmid (1969) reported young being born from 23 July to 11 August. Somewhat farther south, in Belize, Neill (1962) obtained two gravid females that gave birth on 10 and 12 August. A record from Central America is for

19 July after a May capture (Hoover, 1936), and Mole (1924) mentions young being born in May in Trinidad. On 24 July 1984 Dundee saw three DOR recently born specimens within 0.5 km distance just north of Orange Walk, Orange District, Belize.

The lengths of newborn *Boa constrictor* vary substantially, perhaps according to race. Pope (1961) stated that they are 14-25 inches (356-635 mm), with 20 inches (508 mm) being typical. The newborn reported by Hoover (op. cit.) were from 355-370 mm long. But Alvarez del Toro (1982) says that young from Chiapas, México are about 300 mm long; this seems far out of line with the limited or sketchy reports available.

Conopsis lineatus concolor Cope. A DOR specimen taken 7 August 1983 10 km W Chichén-Itzá, Yucatán is from within the known range (Tulane 19765). Another specimen (TU 19804) found DOR 12.6 km SE Sisal toward Hunucma, Yucatán on 28 October 1984 extends the range about 20 km southwest, thus somewhat closer to the northwest tip of the peninsula.

Dipsas brevifacies (Cope). A female DOR specimen (Tulane 19755) from between Cooperativa and Xul, Yucatán, found 11 January 1983, extends the range 54 km north and 48 km ESE of previous reports. The animal is somewhat larger than the maximum reported by Peters (1960), being 378 mm BL and 508 mm total length. The infralabials at 12-14 extend the meristics beyond Peters' counts. Another specimen from 2 km S Ticul, Yucatán (Tulane 19794) taken 23 February 1982 extends the range 31 km east from older reports.

Drymarchon corais melanurus (D,B, and D). Indigo snakes apparently are widespread throughout the peninsula, as evidenced by several DOR specimens encountered by White. Tulane 19789, a skin, represents a brown specimen found 1 October 1982 2 km E La Presumida, Yucatán, a site 31 km ESE of previous records. A roadkill seen 2 km S Othon Blanco, Quintana Roo on 14 January 1984 is a locality some 30 km still farther south from La Presumida. Another seen in a forest south of Calcehtok, Yucatán 21 February 1982 is 62.5 km NNW of previous records, and one seen 10 km SE Sotuta, Yucatán 15 January 1984 is within the known range.

On 10 December 1983 Dundee saw a black specimen on the road in the middle of a mangrove swamp 4 km W and 2 km N of El Remate, Campeche, thus 90 km SW and 84 km NW of records shown by Lee (1980). The habitat seems unusual but Lee (personal communication) says that he has seen them in such a habitat in Quintana Roo, and Neill and Allen (1959) reported that indigo snakes are common in black mangrove forest near Belize City, Belize.

Drymobius m. margaritiferus (Schlegel). Two specimens (Tulane 19761 and 19799) taken DOR 20 km E Celestún, Yucatán on 11 January 1983 and 19 July 1982 document a new locality that is 120 km west of previous records, and another DOR (TU 19805) from 6.1 km E Celestún extends the range almost to the coast. White saw three others DOR 25 km E Celestún on 19 July 1982, and Dundee and Liner saw many live and DOR specimens on México Hwy. 281 between 6 and 16 km E Celestún on 28 October 1984. The habitat along that stretch of highway is dense scrub.

Elaphe flavirufa phaescens Dowling. A DOR 627 mm male (Tulane 19760) from Uxmal, Yucatán taken 16 February 1983 represents an extension of 87 km south and 112 km southwest of previous records in western Yucatán, and 300 km north of the nearest location in Campeche.

Dowling (1952) indicated that the supposed type locality of *Elaphe flavirufa* given by Smith and Taylor (1950) was invalid because specimens from that area (Chichén-Itzá, Yucatán) did not match animals that he had from that site. Dowling thus assigned Chichén-Itzá specimens to a new subspecies *E. f. phaescens* and provisionally assigned the type locality for *E. f. flavirufa* to Campeche, Campeche state. But Smith and Taylor (1966) pointed out that the type of *E. flavirufa* is Izamal, Yucatán. Smith and Taylor stated that the two localities are so close (approx. 55 km - our calculation) that they preferred to regard *phaescens* as a full species. We choose the nomenclature suggested by Wilson and Meyer (1982). Our specimen falls clearly within the parameters of *E. f. phaescens* (29 dorsal blotches, even allowing for counts of two each to accommodate two staggered but connected sets of blotches-but the anteriormost blotch is continuous with a pair of neck stripes that occupy a space sufficient to accommodate two dorsal blotches). Meristics include tail to body length .23, 260 ventrals, 99 subcaudals, 9-8 supralabials, 13-13 infralabials, 1-1 preoculars, 2-2 postoculars, 3-3 anterior temporals, 4-4 posttemporals. Present knowledge of the geographic distribution of *E. f. phaescens* and zone of intergradation with other races of *E. flavirufa* thus remains unclear.

Elaphe t. triaspis (Cope). Tulane specimens 19758, taken one km S Uxmal, Yucatán, and 19759, from between Uxmal and Santa Elena, Yucatán, both DOR 11 January 1983, represent a small range extension of approximately 36 km SW of previous Yucatán records. Tulane 19797 taken 16 July 1982 3 km S Ticul, Yucatán is about 28 km S and 75 km NW of earlier records. Another DOR specimen (TU 19823) from 1 km W Yotholin (between Ticul and Oxkutzcab) taken 4 April 1985 demonstrates further that *E. t. triaspis* probably is a common snake at the periphery of its range.

Immantodes tenuissimus Cope. A freshly killed DOR specimen (TU 19824) of this northern Yucatan Peninsula endemic from km 5 between Muna and Opichen, Yucatán, found just after a squall line passage, extends the known range 75 km S and 128 km WSW. This specimen, a male, measures 633 mm body length and 927 mm total length. It has 44 body blotches plus 7 or 8 not complete, but two of the 44 are coalesced. There are 36 blotches on the tail. There are 247 ventrals, 153 subcaudals, including the tail cone, 9-8 supralabials, 11-10 infralabials, 2-2 preoculars, 2-2 postoculars, 2-2 anterior temporals, 2-2 posterior temporals, and 17 scale rows at midbody.

Lampropeltis triangulum blanchardi Stuart. Tulane 19757, found DOR 4 km S Ticul, Yucatán 9 January 1983, represents an extension 30 km south of previous records. The scale rows are 21-21-17. Williams (1978) shows in a table that three of 11 specimens were 21-21-17, but his description speaks only of 19 scale rows. Our specimen is odd in that the first two subcaudals behind the cloaca are divided, followed by nine single scales, and the remainder are again divided. Williams made no mention of subcaudal condition.

Masticophis m. mentovarius (D,B, and D). A DOR specimen (Tulane 19788) taken 12 January 1984 from 10 km SE Tekax, Yucatán bridges a large distributional gap between the southwestern section of the peninsula, Belize, and the northeastern tip of the peninsula. The locality represents a site 59 km SSE and 109 km NE of the nearest known localities. Another DOR specimen (TU 19807) found 28 October 1984 by Dundee and Liner 10 km W Bella Flor, Yucatán is an extension of 75 km WNW of any previously known locality.

Ninia sebae morleyi Schmidt and Andrews. Tulane 19766, taken DOR 11 January 1983 from between Sayil and Labna, Yucatán, provides a locality 88 km S and 78 km W of previous reports.

Oxybelis aeneus (Wagler). Tulane 19790, found DOR 10 January 1984 between Nunkini and Santa Cruz in the extreme northern tip of Campeche, represents a locality 84 km W and 81 km N of known records.

Oxybelis fulgidus (Daudin). Tulane 19802, found DOR 26 October 1984 15 km NE Maxcanú, Yucatán on México Hwy. 180 extends the range 40 km W and 39 km SW of the closest reported locality and provides a record in the poorly known western $\frac{1}{4}$ of the peninsula. Tulane 19762 found DOR 11 January 1983 between Salvador Alvarado and Benito Juárez, Yucatán is within the known range but 20 km E of known records. Another specimen, documented by a color slide, was seen DOR 6 km N Santa Elena, Yucatán on 22 February 1982 and constitutes a northward extension of 50 km. One other specimen recorded on a color slide was seen DOR 25 February 1982 0.5 km W Teabo, Yucatán, within the known range.

Sibon sanniola (Cope). A DOR specimen (Tulane 19767) taken 7 January 1983 from 3 km S Santa Elena, Yucatán extends the range 78 km S and 93 km N from previous records.

Sibon s. sartori Cope. A freshly DOR specimen (Tulane 19756) found mid-morning 2 km W Dzibilchaltún, Yucatán 11 December 1983 contained a freshly ingested veronocellid slug. Although December is considered to be dry season in that rather arid part of the peninsula, a heavy rain had fallen several days earlier, thus the slugs were probably active and the snakes, in turn, could be active because food was available.

On first inspection this species was mistaken for *Dipsas brevifacies*; the color, black and bittersweet pink, matched perfectly with a description given by Schmidt and Andrews (1936). Further inspection, however, revealed such major differences as lightly keeled scales, a mental groove, and different scale counts.

We are not certain what size this snake attains. Wilson and Meyer (1982) say it is a medium small snake, reporting a maximum length of 588 mm for Honduras, and the largest measured by Kofron (1980) gives 857 mm for the greatest overall length. But Cope (1863) said in his description, "tail one-sixth of the total length"; "Length of head and body 47", of tail 9". This makes the total length 1422 mm! The type specimen is listed as missing.

Stenorrhina freminvillei D,B, and D. A minor extension 9 km southwest of previous records is provided by Tulane 19764 taken DOR between Ticul and Santa Elena, Yucatán 9 January 1983.

Symphimus mayae (Gaije). This northern Yucatan Peninsula endemic, unknown until 1936, apparently is quite common. Rossman and Schaefer (1974) examined 59 specimens and Lee (1980) shows several records west of those known to Rossman and Schaefer. We can add to those records: Tulane 19785, a DOR from 3 km S Santa Elena, Yucatán, taken 8 January 1984 corroborates Lee's most southwesterly record and extends the range about 12 km SE of that rather isolated locality; Tulane 19786, a DOR from 3 km E Opichen, Yucatán, 10 January 1984, constitutes a site 20 km NNW of Lee's most southwesterly record and represents the most westerly record now available; an unsalvageable DOR specimen seen by Dundee 12 December 1983 on México Hwy. 307 in Quintana Roo between the Cancún airport and Puerto Morelos fills in a gap on the northeastern edge of the range, being 50 km S of La Vega, the northernmost record, and 78 km north of a record from 65 km S of Puerto Morelos.

Our two preserved specimens fit within known meristic parameters, but of note is that both have faint indications of three long, darkish stripes on the posterior 2/3 of the venter. Also, Rossman and Schaefer (op. cit.) noted that the color of the anterolateral edges of each dorsal scale in life was orange-yellow. In our specimens the light color on the edge remains readily evident but the light edges disappear on the lower sides as one proceeds posteriorly and there are no light edges on the scales of the tail.

Thamnophis proximus rutiloris (Cope). Lee shows records along the northern coast, in southern Campeche, and far to the east in northern Quintana Roo. Dundee found the species common near El Remate in extreme northern Campeche (Tulane 19803) and Dundee and Liner encountered them 22.5 km N Chunchucmil in far western Yucatán (TU 19806). Areas where they were seen were marshy or scrubby with considerable numbers of temporary pools present. All were seen in late October.

Micrurus diastema (D,B, and D). This highly variable coral snake was considered by Roze (1967) to consist of seven subspecies, a view that he still held much later (Roze, 1982). Fraser (1973) viewed the species to be monotypic, but he was countered by Blaney and Blaney (1979) who reviewed new material from northern Quintana Roo and decided that northern Yucatan Peninsula populations could be assigned to *M. d. alienus* (Werner) and populations in the southern part of the peninsula correspond to *M. d. sapperi* (Werner), an interpretation based on a marked change in the number of black body rings. Fraser had considered the number of rings to be part of a smooth cline. We have three specimens, one from northern Quintana Roo and two from Yucatán, differing so greatly in pattern as to challenge the imagination that they belong to a single race. The species consists of animals that range from those possessing only a neck ring to those having as many as 62 black body rings.

Fraser's analysis centered primarily on areas from which modest or adequate samples were available, but his lumpings of samples on a distributional basis varied, e.g., the entire Yucatán state plus a single northern Quintana Roo specimen were grouped and those from a single locality in Quintana Roo (Felipe Carillo Puerto) were grouped, thus a thorough analysis by either Fraser or Blaney leaves something to be desired in the area of supposed intergradation of *alienus* and *sapperi* type populations. Northern Campeche and southwestern Yucatán continue to be hiatuses in known distribution of the species, as is evident from Lee's (1980) map.

Our three animals include two that extend the known range, and one that is within known distribution. Tulane 19753, a female from 2 km E Opichen, Yucatán, taken 1 August 1983 extends the range 44 km WSW of previous records. It has 23 black body rings and only 5% of the subcaudals undivided. The animal therefore is more like *sapperi* in ring count but more likely *alienus* in subcaudal condition. A male from Uxmal, Yucatán (TU 19752 found DOR 27 September 1983) has 20 black body rings and 64% of the subcaudals undivided, thus it, like 19753, is more nearly *sapperi* in pattern but *alienus* in subcaudal condition. Features such as ventral count, black tail rings, and ring width all fall within ranges described by Fraser (op. cit.) and Blaney and Blaney (op. cit.). Our third specimen, TU 19754, a female, was crossing a road at 11 A.M. on an overcast day 19 February 1983 near Nueva X-can, Quintana Roo. It has only 13 black body rings and in other particulars appears to be more representative of northern populations (*alienus*). One characteristic given by Fraser, ventral count, was extended by Blaney and Blaney to be as high as 206, but they erred in their statement concerning LSUMZ 33364, a female; Fraser indicated 207-223 for females, but males ran only 192-205. Likewise Blaney and Blaney failed to note that LSUMZ 33364 had a ventral minus subcaudal count of 164, the same figure that they gave for a Yucatán specimen (LSUMZ 33365).

The Blaney and Blaney (op. cit.) conclusion that the northern population of *Micrurus diastema* be termed *M. d. alienus*, based on the number of black rings, may seem tenable in the eastern Yucatan Peninsula and perhaps also in western Yucatán based on our specimens. Inasmuch as Fraser (1973) did not include two specimens from Mérida, Yucatán (locality 42 on his map) and because there are additional specimens from southern Yucatán shown by Lee (1980), a clear picture of the distribution of geographic races remains unclear. We note that one physiographic feature, the Sierrita de Ticul, a district of low hills (to 270 m; Heilprin, 1891), may define the boundary for the sudden change in black body ring number. The northern third of the Yucatan Peninsula contains a number of endemic species and disjunct populations of amphibians and reptiles. Lee (1980) examined geologic, physiographic, and climatic details and history of the Yucatan Peninsula and concluded that endemics evolved during changing environmental conditions in the Pleistocene. A wide-ranging species such as *Micrurus diastema* may have responded to those conditions by undergoing evolutionary changes without loss of specific identity. This response plus the existence of the Sierrita de Ticul might offer a basis for subspeciation based on geographic separation.

Bothrops yucatanicus Smith. A male specimen (Tulane 19787) taken alive on the road 12 January 1984, $\frac{1}{2}$ km W Santa Rosa, Yucatán, represents an extension of 37.5 km southwest of previous records. It closely matches the holotype in color and pattern. The animal measures 400 mm BL and 486 mm TL. There are 17 dorsal blotches, many being split and staggered. Scale rows are 25-25-21, ventrals 148, subcaudals 44 including the tail cone, 9-9 supralabials, and 11-12 infralabials.

Crotalus durissus tzabcan Klauber. Tulane specimen 19798 from between Santa Elena and the Kabah ruins, Yucatán, 17 July 1982, is a juvenile or recent birth, as judged by the open umbilicus and only a button present. It measures 345 mm BL and 382 mm TL. Klauber (1956) mentions July 28 as a date of birth, whereas Amaral (1978) gives the statement of "summer", which is an ambiguous statement inasmuch as Brasil straddles the equator.

Summary

In view of the numerous small and large range extensions represented by our collections we suggest that Lee's study may have been premature for a thorough analysis of Yucatan Peninsula biogeography. The paucity of roads in Campeche and western Quintana Roo plus few collecting expeditions to the peninsula surely have kept herpetologists from assembling a thorough knowledge of the fauna. Although the peninsula may appear geographically rather uniform, its diversity of herpetofauna and intriguing distributions clearly indicate that much more attention needs to be focused on the region.

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THE PROPER NAME FOR THE SOUTHERN ATLANTIC COAST
SUBSPECIES IN MÉXICO OF THE LAGARTIJERA,
Dryadophis (REPTILIA: SERPENTES)

Hobart M. Smith and Gonzalo Pérez-Higareda

Abstract

Herpetodryas mexicanus Bocourt, 1890, is an available name in spite of having been first proposed in a synonymy, by virtue of Stuart's acceptance of it in 1941 as a senior synonym of his 1933 *Eudryas boddaertii mexicanus* and the authority of Art. 11(e) of the 1985 edition of the International Code of Zoological Nomenclature.

Dryadophis is validly distinguished from *Mastigodryas*, not only by having apical scale pits, but by a greater hiatus in subcaudal counts (minimum of 83 vs 70) than previously thought (79 vs 70).

Considerable confusion exists in the literature of the past several decades about the proper name for the subspecies of Lagartijera (a vernacular name applied by Alvarez del Toro, 1982:161-162, to members of the genus *Dryadophis*, in allusion to their nearly exclusive diet of lizards) occurring in the coastal plain of eastern México from Tamaulipas to Tabasco. We here review the history of its name, concluding that the proper onymorph is *Dryadophis melanolomus veraecrucis* Stuart, 1941.

In 1933 Stuart first described and named it, as *Eudryas boddaertii mexicanus*, from Zacualpan, Veracruz--the only representative of the genus on Atlantic slopes of México except for the nominotypical subspecies of the northern part of the Yucatán Peninsula. In 1941, however, he substituted the new subspecific name *veraecrucis* (Stuart, 1941:91), in the combination *Dryadophis melanolomus veraecrucis*, justifying that action by the explanation that "The name *mexicanus* is preoccupied by *Herpetodryas mexicanus* Bocourt (1890:722); this author placed under *Drymobius* (*Eudryas*) *laevis* a specimen so labelled by Jan." The latter taxon he considered congeneric--even conspecific--with his subspecies *mexicanus*, as *Dryadophis melanolomus laevis* (Fischer), making his (Stuart's) name a junior secondary homonym of Bocourt's *mexicanus* and thus requiring replacement under Arts. 35 ("a specific name is to be rejected as a homonym when it has previously been used for some other species or subspecies of the same genus.") and 36 ("Rejected homonyms can never be used again.") of the International Rules of Zoological Nomenclature then in effect.

However, the 1961 edition of the Code explicitly stated (Art. 11(d)) that "A name first published as a synonym is not thereby made available." This categorical statement was modified in the 1985 edition of the Code by inserting the word "junior" in front of "synonym," and adding: "...unless prior to 1961 it has been treated as an available name and [our italics] either adopted as the name of a taxon or treated as a senior homonym..." (Art. 11(e)).

Stuart (1941:91) obviously did consider *Herpetodryas mexicanus* Bocourt, 1890, an available name, and he treated it as a senior homonym of his own *Eudryas boddaertii mexicanus* of 1933, and since those actions transpired prior to 1961, they are acceptable under the 1985 Code. In the interest of nomenclatural stability it is just as well, although it should be pointed out that under the 1961 code (and its revision in 1964), the name for the taxon would have reverted to *mexicanus* (in the combination *Dryadophis melanolomus mexicanus*), had the situation been noticed and acted upon prior to 1985. Fortunately it was not, else it would now be necessary to shift back again.

Another peculiarity of the situation is that although, for the purpose of replacement of Stuart's *mexicanus*, the name *mexicanus* of Bocourt was accepted as available and therefore to be accounted for in nomenclatural synopses, Bocourt's name has never been accepted or allocated as a synonym of any other in any other context, in any work. Even in Stuart's 1941 monograph, in which *D. m. veraecrucis* was first proposed, Bocourt's *H. mexicanus* is not listed in the synonymy of *D. m. laevis*, nor does it appear in his 1963 synonymic checklist of the herpetofauna of Guatemala, or in Peters and Orejas-Miranda's synonymic catalog (1970) of neotropical snakes. It is a forgotten name, although by virtue of the 1985 Code's provisions it is a legally available name, and should be recognized as a junior synonym of *Dryadophis melanolomus laevis*, as well as a senior secondary homonym of *Eudryas boddaertii mexicanus*.

Art. 59(b) of the 1985 edition of the Code also makes it clear that, since Stuart's *Eudryas boddaertii mexicanus*, a junior secondary homonym, was replaced before 1961, it is "permanently invalid." Its replacement, *B. m. veraecrucis*, is thus assured of permanent validity, so long as the population to which it applies is accepted as a valid subspecies.

The generic name with which the replacement name *veraecrucis* was originally associated (*Dryadophis*) has also suffered an unfortunate exchange, although it properly should be restored to its original status. Nevertheless a considerable literature of major influence, still felt, accumulated over the past several decades using the name *Mastigodryas* in lieu of *Dryadophis*. Doubt about the proper name still persists. We here provide additional argument for maintenance of *Dryadophis* as valid and separate from *Mastigodryas*.

The trouble all began in 1944, when Dunn (1944:204) stated that *Mastigodryas danieli* Amaral, 1934 (the only species of the genus), is a synonym, with pitless scales, of *Dryadophis b. boddaertii*. He did not, however, for unknown reasons, abandon the name *Dryadophis*. Similarly, Romer, in his broadly influential *Osteology of the Reptiles* (1956:577), listed "*Dryadophis* Stuart 1939" as a valid name, giving "*Eudryas* Fitzinger 1843" and "*Mastigodryas* Amaral 1934" as synonyms. Fitzinger's *Eudryas* of 1843 was eliminated as a valid name because of junior homonymy with *Eudryas* Boissduval, 1836 (Lepidoptera), as first pointed out by Brongersma (1937:4-5); hence Stuart (1939:55) substituted the name *Dryadophis*, being unaware of the possible pertinence of Amaral's *Mastigodryas* (1934:157-159). Noting that the

situation seemed to call for adoption of *Mastigodryas* over *Dryadophis*, and being reluctant to see a widely adopted name replaced by an extensively unfamiliar one, Smith (1963:230) appealed to the International Commission on Zoological Nomenclature to reject Amaral's name, thus protecting the familiar *Dryadophis*.

The latter action promptly led Amaral (1964:13) to point out that Dunn erred in considering *M. danieli* to be congeneric with *Dryadophis* (and conspecific with *D. b. boddaertii*), since all members of the latter genus have two apical scale pits and 79 or more subcaudals, whereas *M. danieli* lacks scale pits and has 70 subcaudals in the only known specimen.

Actually the subcaudal disparity may be greater than stated. True, Stuart (1941:14) stated in his classic monograph of *Dryadophis* that the subcaudals vary from 79 to 136 in the genus as a whole, and presumably Amaral's figure of 79 as a minimum was drawn from Stuart's summary. Yet the counts given by Stuart for individual species and subspecies are less than 100 (minimally) only in *D. bifossatus* (86-105 in its three subspecies), *D. pulchriceps* (86-99), *D. pleei* (83-105), *D. melanolomus alternatus* (85-110) and *D. b. boddaertii* (79-113). However, the graphs of subcaudal counts for the latter subspecies, representing every area from which specimens examined were listed (pp. 67, 69, 70), show no counts lower than 95 or 96 (our estimate) on either p. 72 (fig. 7) or 75 (fig. 8). A discrepancy exists between these graphs and the one on p. 25 (fig. 2), where 93 or 94 subcaudals are shown for *D. boddaertii*. Nowhere, in other words, is the count of 79 evident in the detailed presentations of data; that count therefore may well be a lapsus, and if so 83 would stand as the lowest count known for *Dryadophis*.

Our point is simply that perhaps the hiatus between *Mastigodryas* and *Dryadophis* may be greater than stated by Amaral. If his record of 70 subcaudals (for a complete tail), and the absence of scale pits, is correct, there can be no question of the generic distinctness of the two groups, and that *M. danieli* cannot be considered a synonym of *D. b. boddaertii*.

Nevertheless Dunn was so misled, although he apparently did not see the type. On the other hand Peters (in Peters and Orejas-Miranda, 1970:190) did see the type, and still thought *Dryadophis* was congeneric with it, although retaining *M. danieli*, its type species, as validly distinct. He apparently had not, however, seen Amaral's (1964) defense of *Mastigodryas* as a separate genus from *Dryadophis*. Acting upon the assumption of their synonymy, however, Peters and Orejas-Miranda (1970:190-195) finally adopted the name *Mastigodryas* for the genus.

Smith and Larsen (1973) later appealed to the herpetological community to accept Amaral's (1964) justification for retention of both genera, but the work by Peters and Orejas-Miranda (1970) is such a widely accepted standard that most authors have subsequently followed their lead, as for example Scott, Savage and Robinson (1983:373). Fortunately exceptions do exist in which *Dryadophis* is retained, as for example Alvarez del Toro (1982:227) and Wilson and Meyer (1985:43-46).

Obviously the question of relative status of these two nominal genera cannot be regarded as definitively resolved until more material of *Mastigodryas* sensu stricto has been examined. Until then, however, the evidence now available supports the conclusion that *Dryadophis* should be retained as valid.

The currently proper name for the subspecies of lagartijera of the mainland Atlantic coast of Mexico is thus *Dryadophis melanolomus veraecrucis* Stuart, 1941.

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NOTES ON THE BOG TURTLE, *Clemmys muhlenbergi*, IN WARREN COUNTY, NEW JERSEY

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Abstract

Five additional sites for *Clemmys muhlenbergi* are reported and these double the number of populations of this turtle known from Warren County, New Jersey. Data on 57 captures and recaptures of a minimum of 37 bog turtles found are summarized and presented. All but one turtle were adult. The mean straight-line carapace length of adult males was 93.74 mm, and of adult females 89.26 mm. The majority (58.3%) of adults were male. Behavior of captures and recaptures was predominantly (52.6%) basking on land and basking in shallow water (12.3%). Habitat was in species-typical, open-canopy, well-lighted, heavily-vegetated, well-watered hollows with abundant deep soft mud substrate.

Introduction

Arndt (1977) indicated that the bog turtle, *Clemmys muhlenbergi*, is more secretive than rare, and suggested (Arndt, 1978) that it should be expected in some states from which it had then not been reported. That he was correct is supported by the following few examples of the many which could be given. The first bog turtle in Maryland was found in 1941 (McCauley and Mansueti, 1943). It is now known from some 177 sites in this state and consequently it has been deleted from the Maryland list of endangered species (Dawson, 1984). The species has recently been reported from Georgia (Hale and Harris, 1980) and South Carolina (Herman and Putnam, 1982).

As a result of recent new information on bog turtle behavior and ecology (Arndt, 1977, and see literature summary in Bury, 1979) and of more intensive searching, additional populations of this turtle continue to be found, even in portions of its range from which it has long been known, such as in northern New Jersey. Zappalorti and Johnson (1982) list four populations of the bog turtle from Warren County, New Jersey, from the townships of Frelinghuysen, Oxford, Pahaquarry, and Liberty, discovered, respectively, in 1955, 1974, 1978, and 1980. R. T. Zappalorti (pers. comm., 1986) has a record of a fifth population from the county, from Allamuchy Township, and discovered in 1983. During field surveys to obtain ecological data on a number of plant and animal species on a proposed reservoir-construction project site in the county, my colleagues and I discovered five additional populations in 1983 and 1984. Ten populations of the bog turtle are now known from Warren County. Other populations no doubt occur, since appropriate and unsearched habitat is abundant.

Method and Materials

A survey for the bog turtle was undertaken on the approximately 3,000-acre reservoir project site, located 6.5 km ENE of Phillipsburg, Warren

County. Field survey effort for the turtle was of limited intensity and confined to the site in 1977, 1981, and 1982. The search effort on the site was increased and the area surveyed was expanded to a radius of some 13 km from the site in 1983, 1984, and 1985.

Potential bog turtle wetland habitat was searched for by driving roads and highways, by the use of maps, and by searching woods and fields on foot. All prospective habitat was then ground-searched, almost exclusively in the months April through June, largely during calm, sunny, and warm weather, and primarily between 10 A.M. and 5 P.M., when conditions for finding turtles are optimal. In addition, possible turtle records and related data were solicited from a forester and security persons frequently on the site.

Data recorded on each field search included time of search; weather (including air and water temperature); habitat; and amphibian, reptile, and mammal species-associates. Recorded for each turtle was its sex, and for almost all specimens, the straight-line carapace length (with calipers) and weight (with an O'Haus triple beam balance); cloacal temperature was taken on several specimens (with a Shultheis quick-recording thermometer). All but two adult males and two adult females were marked by code notches filed in the marginals. Depending on whether or not any of these turtles were recaptured, the actual number found could be up to four more than those notched (and the conservative number recorded). All turtles were released at the spot of capture and this usually marked with a stake. Most turtles were photographed. No specimen was sacrificed.

Results and Discussion

Five populations and a minimum of 36 live bog turtles were found in southern Warren County in 1983, 1984, and 1985, in the townships of Harmony (three populations) and Washington (two populations). Two of the sites were discovered in 1983, and three in 1984. One population was on the proposed reservoir site, the other four off the site. The survey area is in forested rolling hills with much open agricultural land and in the Highlands section (Robichaud and Buehl, 1983) of the state.

In addition, one group of three predator-destroyed bog turtle eggs containing two well-developed dead embryos (now in the collection of Stockton State College) was found on 2 June 1983 at one of the sites among scattered tussock sedge, *Carex stricta*, and clump grasses. Last, one adult male bog turtle found in this survey on 3 June 1983 is almost certainly from Warren County but of dubious locality and is known to be one of four adults marked and released by R. T. Zappalorti (pers. comm., 1986) in 1982. It was found near the release spot, at an eleventh site in Warren County. Because no other bog turtle was found there despite intensive search, and because the locality is not believed to be appropriate bog turtle habitat, this is not considered a valid site. However, sex, size, and activity data on this specimen are included in this paper.

The number of live turtles recorded from each site was 1,3,5,9, and 18. If none of the unnotched and released turtles were recaptured, the number actually found at the last two sites was 11 and 20. The largest numbers of turtles were recorded from those sites where the search effort was the greatest.

All live bog turtles but one are considered to be adult, as based on their well-developed secondary sexual characteristics (pronounced differences in tail and plastron morphology). Of the minimum total of 37 turtles taken, 21 were male and 15 were female; the one sub-adult was of unknown sex. Carapace length of all adult males ranged from 81.0-103.0 mm ($\bar{x}$ = 93.74 mm), and of all females 82.0-97.3 mm ($\bar{x}$ = 89.26 mm); for the sub-adult it was 68.3 mm. The smallest adult (a male) had a carapace length of 81.0 mm. One female of 84.0 mm carapace length was observed being courted or mating. Arndt (1977) considered specimens smaller than 85 mm straight-line carapace length to be sub-adult. Apparently, however, sexual maturity is reached at a smaller size, as based on the preceding data and on Barton and Price (1955) who indicate that the female may be sexually mature at a carapace length of 75 mm and of Ernst (1977) who concluded that sexual maturity is probably attained by both sexes at about this same length.

Weight of 18 adult males ranged from 79.5-141.2 g ($\bar{x}$ = 113.87 g) on the basis of 19 weights (one specimen weighed twice), while adult females (n = 15) ranged from 91.1-144.4 g ($\bar{x}$ = 124.38) on the basis of 18 measurements (three specimens weighed twice). Differences in weight between time of capture and recapture of the four turtles weighed twice range from 1.5-9.6 g ($\bar{x}$ = 6.45 g).

Fifty-seven live captures and recaptures were recorded, all in May (80.7% of the total) and June (19.3%). The number of captures and recaptures and the percentage of the total by month and sex were: May--males 21 (37.5%), females 25 (44.6%); June--males 7 (12.5%), and females 3 (5.4%). The sub-adult was taken on 5 June 1984. The earliest capture date was 5 May 1983, and the latest 13 June 1985. All specimens were taken between 10:30 A.M. and 4:50 P.M.

Most turtles were found in sunny, clear and calm weather, although some were found in hazy, partly cloudy, breezy, overcast, and rainy conditions. Because of a probable turtle "lag period" in response to change in the weather, and because of the changeable weather encountered during many of the field searches, it seems fruitless to try to relate turtle behavior to instantaneous weather conditions.

Turtle behavior at the time of capture and recapture (n = 57) was recorded, although the appearance of the researcher may have affected behavior in some cases. As nearly as could be determined, behavior was: basking on land, 30 records (52.6%); basking in shallow water, 7 (12.3%); moving through wet meadow, 8 (14.0%); burrowed into mud/grass, 5 (8.8%); mating or courting, 4 (7.0%); moving quickly in rivulets, 2 (3.5%); and quiet under water, 1 (1.8%). No difference in behavior by sex was noted. Mating/courting turtles were observed on 10 May 1983 and 24 May 1984, in weather

that was clear and sunny, and bright and sunny with breezes. In both cases the female was concealed under water with the male above her and partly out of water.

Air/water temperatures (°C) for turtles basking ranged from 14.0-29.4/15.0-28.9; moving through grass, 15.0-21.1/16.1-21.1; burrowed into mud/grass, 18.9-26.7/23.3-25.8; moving through water, 21.1-24.4/21.1; and quiet underwater, 23.9/27.8. Cloacal temperature (°C) of turtles basking ranged from 21.3-28.0, and in one turtle burrowed into mud/grass it was 28.1.

Of the minimum of 37 turtles caught alive, 9 (24.3%) were recaptured. Six turtles (three males, three females) were recaptured once, one male was recaptured twice, one female was recaptured three times, and one female was recaptured five times. Recapture intervals ranged from five days to two years and 24 days, with sex apparently not of significance.

All turtle populations in this survey were found in typical bog turtle habitat and similar to that described by Arndt (1977) and as summarized by Bury (1979). All sites were in open-canopy, well-lighted, heavily-vegetated hollows well supplied with clean flowing water in rivulets, small streams and springs, with abundant standing shallow water, and with areas of deep soft mud. Area of habitat ranged from approximately 1.5 to 10 acres. One population was in a wet cattle pasture, another was partly in an abandoned sand/gravel extraction operation in succession from pond to marsh, and the other three populations were in more or less natural wetlands. Although quantitative data are lacking, standing water at the sites was noticeably reduced during dry and hot weather. Soil type at the sites ranged from loam to very stony loam. Exposed and buried rock was conspicuous throughout the two largest sites.

Plant species diversity was pronounced but differed somewhat among the sites. However, each site usually included the typical bog turtle-habitat indicator species (Arndt, 1977, and summary by Bury, 1979) of broad-leaved cattail, *Typha latifolia*; skunk-cabbage, *Symplocarpus foetidus*; sedges, *Carex* spp.; speckled alder, *Alnus rugosa*; sensitive fern, *Onoclea sensibilis*; and sphagnum moss, *Sphagnum* sp. Other plants each noted at two or more sites included sweetflag, *Acorus calamus*; black willow, *Salix nigra*; common rush, *Juncus effusus*; spikerush, *Eleocharis* sp.; bulrush, *Scirpus* sp.; rice cut-grass, *Leersia oryzoides*; and straw-colored cyperus, *Cyperus strigosus*.

Herptile species-associates (in decreasing order of abundance) for the five sites combined were green frog, *Rana clamitans melanota*; pickerel frog, *R. palustris*; bullfrog, *R. catesbeiana*; American toad, *Bufo a. americanus*; northern red salamander, *Pseudotriton r. ruber*; eastern box turtle, *Terrapene c. carolina*; wood turtle, *Clemmys insculpta*; common snapping turtle, *Chelydra s. serpentina*; spotted turtle, *Clemmys guttata*; and northern black racer, *Coluber c. constrictor*. The eastern meadow vole, *Microtus p. pennsylvanicus*, and shrews and their runways and nests were abundant at all sites.

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NEW DISTRIBUTIONAL RECORDS FOR SOME MEXICAN
REPTILES AND AMPHIBIANS

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Abstract

Seven new distributional records for three reptiles and two amphibian species in the states of Hidalgo, México, Michoacán, Puebla and Sonora are presented, with brief taxonomic and ecological observations.

Recent personal collections have revealed a number of noteworthy additions to knowledge of the distribution of Mexican amphibians and reptiles, some here recorded. All cited specimens are in the herpetological collections of the Museo de Zoología A. L. Herrera, Facultad de Ciencias (MZFC) and of the Escuela Nacional de Estudios Profesionales Iztacala (ENEP-I), both of the Universidad Nacional Autónoma de México, and situated in Ciudad de México (Distrito Federal), and Tlalnepantla (Estado de México), respectively.

Ambystoma lacustris Taylor and Smith

1. One recently metamorphosed individual (MZFC, unnumbered) was found in a pool in Río Honey, near Honey (the town's name is a word in the Otomí language), Puebla, 2250 m. The river is on the border between the states of Puebla and Hidalgo, very near the western slopes of the Sierra Madre Oriental. The pool from which the specimen was taken is in a very rocky, montane section of the river, about 3 m in diameter and less than 1 m in depth. Several larvae were seen but not captured. The surrounding habitat is a pine-oak forest of *Pinus patula*, *Quercus affinis*, *Q. crassifolia*, with *Cupressus*, *Clethra*, *Cornus* and *Crataegus*. A gallery forest of *Alnus* lines the river.

Other species of common occurrence in the vicinity are *Chiropterotriton* sp., *Pseudoeurycea cephalica*, *Sceloporus grammicus* and *Abronia t. taeniata*.

The specimen agrees well with the description of the species (Taylor and Smith, 1945:531-534, pl. 18, figs. 1-4) and with other material (see following), having a depressed head, swollen eyes and a greenish coloration.

This is the first record of the species for the state of Puebla, and extends its known range some 145 km northeast of the type locality and out of the Valle de México.

2. One adult and 32 larvae (MZFC, unnumbered) were taken from Laguna de Tecocomulco, Hidalgo, 25 air km SSW Tulancingo, 2500 m. The locality lies at the northern extremity of the Llanos de Apán, in the northeastern part of the Valle de México. The Río Papalote supplies the Laguna de Tecocomulco and drains it into the Lago de Zumpango, the type locality.

The valley occupied by the lake is subject to intense agriculture, with extensive *Agave* fields. The natural vegetation is grassland, with isolated *Pinus*, *Quercus*, *Buddleia* and *Juniperus*. The surrounding mountains have pine forests of *Pinus teocote* and *P. patula*, and mixed forests of *Quercus*, *Pinus montezumae* and *Abies religiosa*. In the lake are extensive areas of "tulares" (*Scirpus*) and several aquatic phanerogams (*Potamogeton*, *Myriophyllum*, *Hidrocotyle* et al.).

The adult was found under a stone near the water. The larvae were collected in 30 minutes with hand net in water less than 1 m in depth and in an area of less than 300 m². They were microsympatric with larvae of *A. tigrinum velascoi*, of which about 50 were taken along with the *A. lacustris*. Small larvae seemed to prefer shallow areas where *Potamogeton* was dominant and green algae abundant, whereas larger larvae were more common in deeper waters where other plants, including *Scirpus*, were dominant.

One specimen was found in the stomach of a *Thamnophis eques*, a species very common there and probably one of the salamander's major predators. Another aquatic amphibian common there was the recently described *Rana spectabilis* Hillis and Frost (1985:5-10, figs. 1-3).

The lake has a surface area of some 30 km², and probably the largest population in existence of *A. lacustris*. All specimens agree well with the original description, having a depressed head, swollen eyes, dorsal fin reaching only to neck, and a greenish, unspotted coloration.

The microsympatric *A. t. velascoi* differs from *A. lacustris* (in parentheses) as follows: dorsum brown-gray or darkened white (pale green); venter with a conspicuous reticulation of yellow and dark brown or gray (yellowish white, almost or totally immaculate); head not conspicuously depressed (depressed); dorsal fin extending to head (to neck); tail and caudal fin curved down at top (straight). In addition, *A. t. velascoi* is typically stouter and larger than *A. lacustris*. Despite these differences, not always can larvae of the two species be distinguished with certainty; a detailed study of the two taxa is needed to determine their limits of variation, and the most unequivocal means of differentiating them.

The present record is the first for Hidalgo, and extends the known range some 80 km ENE.

Pseudoeurycea cephalica cephalica (Cope)

One adult and one subadult male (MZFC-A-0073, series) were taken on the western slope of Cerro Cacique, 10 km NE Zitácuaro, Michoacán, 2150-2200 m, in the Sierra de Angangueo, southern central Eje Neovolcánico Transversal. The habitat was a very humid slope of pine forest and cloud forest composed of *Alnus*, *Quercus*, *Arbutus*, *Fraxinus*, *Abies* et al., with great abundance of epiphytes such as *Tillandsia*, lichens, mosses, Crassulaceae, Piperaceae, Cactaceae and Orchidiaceae.

The specimens were found under small pieces of wood, in extremely moist situations, microsympatrically with *P. longicauda*. Other common species were *P. bellii*, *Eleutherodactylus hobartsmithi*, *Eumeces brevirostris*, *Conopsis biserialis*, *Thamnophis cyrtopsis collaris* (as of Webb, 1966:60-63, fig. 3) and *Storeria storerioides*.

The two examples agree with *P. c. cephalica* as keyed by Smith and Taylor (1948:25-26). They constitute the first record for Michoacán, although the known range of the species elsewhere indicated occurrence there.

Sceloporus grammicus disparilis Stejneger

1. A series of four is from the Sierra de Monte Bajo, 2500-3000 m, municipality of Nicolás Romero, state of México, as follows: Cahuacán ((ENEP-I-025); Transfiguración (ENEP-I-024, 100); Villa del Carbón (ENEP-I-023). All were collected on dead trees in oak and pine-oak forests, where they occurred microsympatrically with *S. palaciosi* Lara (1983:6-13, figs. 3-5). Scale counts of the two series (12 *S. palaciosi* in parentheses) are as follows: dorsal scales, interparietal to base of tail, 68-73, $\bar{x}$ 71.5) (75-80, $\bar{x}$ 80); ventral scales, 48-71, $\bar{x}$ 50 (48-56, $\bar{x}$ 53.1); femoral pores 15-16, $\bar{x}$ 15.2 (14-20, $\bar{x}$ 16.3). Several pattern differences also exist.

The present records are the first for the state of México and extend the known range of the taxon about 150 km southward from Jacala, Hidalgo.

2. Another series of 16 (MZFC, unnumbered) is from the Sierra Madre Occidental of extreme eastern central Sonora, 2000 m, near Yécora (220 km ENE Guaymas, Sonora, and 230 km W Cuauhtémoc, Chihuahua), Sonora, as follows: 3-4 km NW, 5-7 km SE, 4-5 km E, 13 km NW Yécora. All were collected on mainly live trees in pine and pine-oak forests. Other species occurring commonly in the same region were *Ambystoma r. rosaceum*, *Hyla eximia wrightorum*, *H. arenicolor*, *Rana tarahumarae*, *Elgaria k. kingii*, *Eumeces callicephalus*, *Sceloporus j. jarrovi*, *S. poinsetii*, *S. scalaris slevini*, *S. virgatus*, *Lampropeltis pyromelana*, *Thamnophis cyrtopsis* and *Crotalus lepidus klauberi*.

These specimens agree with the diagnostic scale row count of *S. g. disparilis* (Smith and Taylor, 1950:119) of 52-74, having 58-70, $\bar{x}$ 63.2. Sites and Dixon (1981) regarded *S. g. disparilis* a junior synonym of *S. g. microlepidotus*, on the bases of (1) occurrence within its purported range of other taxonomically distinct populations, and (2) supposed existence of a cline in dorsal scale counts, increasing southward. However, there is no theoretical imperative precluding existence of taxonomically distinct populations completely surrounded by *S. g. disparilis*, and if there is a cline in dorsal scale counts, it is reversed southward by *S. g. grammicus*. Indeed, evidence now at hand (Lara, in prep.) indicates that *S. g. microlepidotus* and *S. g. disparilis* have distinctive karyological and ecological as well as morphological characteristics suggesting that they in reality are different species.

Xenosaurus grandis grandis (Gray)

One adult female (MZFC, unnumbered) is from 5 km NE Azumbilla, Puebla (28 air km NNE Tehuacán), 2100 m. The area is a mountain range where the Sierra de Tecamachalco and the Cumbres de Acultzingo meet, near the common border of Veracruz and Puebla. Ecologically it is a ecotone between the Pueblan desert of the Valley of Tehuacán and the tropical evergreen forests of the eastern slope of the Sierra Madre Oriental.

The specimen was found in a small canyon in a rock crevice in a desert scrub habitat. On the opposite slope was a pine forest (*Pinus cembroides*); *Quercus* scrub occurred two km N in the canyon, and *Quercus* cloud forest five km N, on the Cumbres de Acultzingo.

The transition nature of the area where the lizard was found is documented by the several common species there of xeric affinities (*Bufo occidentalis*, *Sceloporus grammicus*, *S. jalapae*, *S. megalepidurus pictus*, *S. spinosus*, *Toluca lineata acuta*), occurring in conjunction with several others of mesic affinities, as is *Xenosaurus* (*Pseudoeurycea bellii*, *Thorius*, *Sceloporus* f. *formosus*, *S. mucronatus aureolus*, *Abronia taeniata graminea*, *Thamnophis chrysocephalus*, *T. godmani* [as of Rossman et al., 1982:126, 160]).

The characters of the single specimen agree with those of the nominotypical subspecies (King and Thompson, 1968:93-100), of which it would be expected to be representative on distributional grounds. It is, however, the first to be recorded in Puebla.

Thamnophis eques megalops (Kennicott)

A single subadult male (MZFC, unnumbered) is from near Coatepec de Morelos (San Francisco), 5 km E Zitácuaro, Michoacán, 1900 m, in pine-oak forest of the Sierra de Angangueo, south-central Eje Neovolcánico Transversal. The area is a transition zone between the temperate forests of *Quercus* and *Pinus* and the tropical deciduous forests of the Balsas Basin.

The specimen measures 520 mm s-v, tail 161 mm; dorsals in 21-19-17 rows; ventrals 168; caudals 82, supralabials 9-9; infralabials 10-10; preoculars 1-1; postoculars 4-4; temporals 1-3; first dorsal scale row keeled, vertebral stripe 3 scales wide on neck, $3/4 + 2 + 3/4$ scales wide posterior to neck, straight-edged; lateral stripe conspicuous, on rows 3 and 4. These features conform with the diagnostic character-states of *T. e. megalops* (Smith, 1942:115).

The present record is the first for the subspecies from Michoacán; the nominotypical subspecies has been recorded from the southern part of the state.

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SYSTEMATIC STATUS OF THE SPRING PEEPER, *Hyla crucifer*
(AMPHIBIA: HYLIDAE)

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Approximately fifteen years ago, the senior author and two of his colleagues, Dr. Raymond Morgan and Dr. George Drewry, both then of the University of Maryland, began looking for a simple electrophoretic technique which would allow rapid and certain identification of closely similar species of Anuran amphibians. Homogenized leg-muscle protein was available in large quantities, even in the smallest of frogs; was easily prepared; and gave consistently excellent electrophoretic results. As test animals for their work they used all of the species of *Eleutherodactylus* then known to occur in Puerto Rico, as well as most of the North American hylids. The technique worked well and they were, indeed, able to easily distinguish between closely similar species of both the hylids and the leptodactylids which they studied. Unfortunately their work suggested several problems which they had hoped to resolve before publishing their results: The two most strikingly similar Puerto Rican *Eleutherodactylus* (*coqui* and *portoricensis*) were electrophoretically most dissimilar; *Limnaeodus* was essentially identical to *Pseudacris*; and *Hyla crucifer*, on which earlier limited studies of LDH, hemaglobin, and albumin had suggested a striking similarity to *Pseudacris*, had muscle proteins quite similar to those of *Hyla* and quite dis-similar from those of *Pseudacris*.

The search for solutions to these problems lead to a number of delays so that, ultimately, other investigators independently published on both the muscle protein technique and the biochemical relationships of the Puerto Rican *Eleutherodactylus*. This earlier work, as usually happens under such circumstances, was essentially forgotten and would have probably remained so except for a comment recently made by the junior author while collecting frogs in a very cold Maryland swamp: "You know" he said "the spring peeper just doesn't act like a tree frog." This idea, of course, was nothing new. A number of anuran biologists and systematists had formerly expressed essentially the same view. Ralin (1970), for example, in arguing against the continued recognition of *Pseudacris* stated that, if *Pseudacris* continued to be recognized (which it has) then several other genera, including a monotypic genus for *Hyla crucifer* would have to be erected. Our limited information on biochemistry suddenly brought the entire problem into clear focus: Perhaps "*Hyla crucifer*" (Figure 1) was, indeed, neither a *Hyla* nor a *Pseudacris*.

In the present paper we review the literature which clearly compares *Hyla crucifer* to both *Pseudacris* and other Holarctic members of the genus *Hyla*; discuss results of earlier work with muscle proteins involving the genera *Hyla* and *Pseudacris*, and suggest that *Hyla crucifer* is a member of a monotypic genus exhibiting an impressive array of osteological, morphological, biochemical, and behavioral characteristics of both *Hyla* and *Pseudacris*.

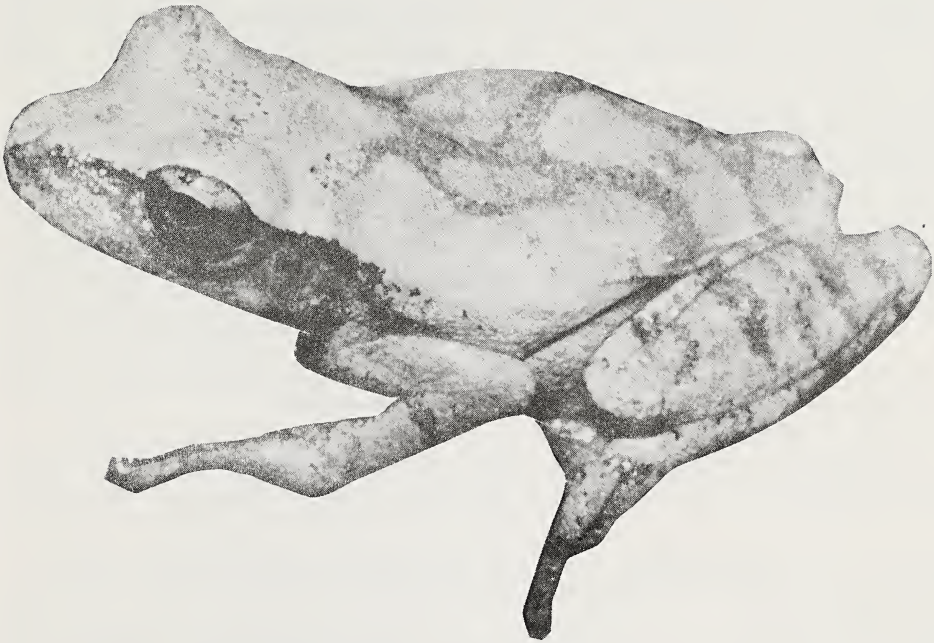


Figure 1. *Hyla crucifer*. Photograph by Herbert S. Harris.

Osteology

Gaudin (1973a), using sixteen osteological characters, demonstrated a considerable amount of osteological variation in members of the genus *Pseudacris*, and used these differences to define two species groups within the genus: The *ornata* group (containing *P. ornata* and *P. streckeri*) and the *nigrita* group (containing *P. branchyphona*, *P. brimleyi*, *P. clarki*, *P. nigrita*, and *P. triseriata*). In a later paper (Gaudin, 1974) he made detailed osteological comparisons between all members of the genera *Acris*, *Pseudacris*, and *Limnaeodius*, and many of the Holarctic members of the genus *Hyla*. In spite of the variations previously observed in *Pseudacris*, he noted eight osteological characters which separated all *Pseudacris* from most of the Holarctic *Hyla*. Three of these characters suggested distinct osteological similarities between *Hyla crucifer* and all members of the genus *Pseudacris* (Table 1).

Table 1. Osteological characters which separate Holarctic *Hyla* from *Pseudacris*. Data from Chantell (1964), Gaudin (1969, 1974), GoIn (1958), and authors observations.

<u><i>Hyla</i></u>	<u><i>Pseudacris</i></u>
More than 10 premaxillary teeth.	Less than 10 premaxillary teeth.
Average numbers of maxillary teeth ca. 37 to 61 (except in <i>Hyla crucifer</i>).	Average numbers of maxillary teeth 32 to 46.
Nasal and sphenethmoid bones not articulated, or only very slightly so.	Nasal and sphenethmoid bones extensively articulated.
Sphenethmoid not projected forward between the nasals.	Sphenethmoid projected anteriorly between the nasals for more than half the length of the later.
Prevomers not in articulation with the sphenethmoid (except in <i>Hyla crucifer</i> and <i>H. chinensis</i>).	Prevomers overlap and articulate with sphenethmoid.
Anterior end of dorsal ridge of urostyle perpendicular to long axis of urostyle.	Anterior end of dorsal ridge of urostyle sloped at angle of approximately 45 degrees.
Omosternum less than half the length of the epicoracoids (except in <i>Hyla crucifer</i>).	Omosternum more than half the length of the epicoracoids.
An ilial ridge, if present, moderately- to well-developed.	Ilial ridge absent or very weakly developed.
Mid-point of the ilial protuberance always posterior to the anterior boarder of the acetabulum (except in <i>Hyla crucifer</i>).	Ilial protuberance completely anterior to anterior boarder of acetabulum.

Gaudin's conclusions (1974) concerning the ilial ridge were somewhat misleading in that he suggested that an ilial ridge was present in all of the *Hyla* which he studied, and absent in all *Pseudacris*. This ridge, first noted by Tihen (1960) in the genus *Acris* and later discussed by Lynch (1962, 1963) appears to be more variable than Gaudin supposed. Lynch (1963) noted that "several species of *Hyla* occurring in the United States have an ilial ridge as do some *Pseudacris*." In those species of *Hyla* in which an ilial ridge is present, the ridge is typically well-developed (as in *Hyla crucifer*), while in the three species of *Pseudacris* in which an ilial ridge has been reported (*P. ornata*, *P. nigrata*, and *P. brimleyi*) it has been described as a "low, short dorsal creast, or intimation thereof" (Chantell, 1968). The ilial ridge is entirely absent in most *Pseudacris*, and only very weakly developed in those species in which it has been reported (Tihen, 1960, and present research). It is likewise entirely absent in some North American *Hyla* (for

example *H. cf. regilla* (a fossil) and *H. cinerea* (Chantell, 1970, and Lynch, 1962, 1963); but is moderately- to well-developed in most of the North American species (including, oddly, recent specimens of *H. regilla*). In terms of the ilial ridge *Hyla crucifer* is more closely similar to certain North American *Hyla* than to any of the members of the genus *Pseudacris* (as Gaudin implied), although the character itself is admittedly more variable than he supposed.

Chantell (1964) presented a detailed study of the position of the anterior edge of the dorsal protuberance of the ilium in relation to the anterior edge of the acetabular fossa in a variety of different species of frogs. He found considerably more overlap between *Pseudacris* and *Hyla* than Gaudin later noted in his study (Gaudin, 1974) which was based on the position of the mid-point of the dorsal protuberance. In Chantell's study, *Hyla crucifer* and *H. eximia* were the only two of nine currently recognized species of *Hyla* studied in which the anterior edge of the dorsal protuberance was clearly anterior to the anterior edge of the acetabular fossa. In this respect *Hyla crucifer* (and *Hyla eximia*) are more similar to the various members of the genus *Pseudacris* than to other *Hyla*.

Gaudin (1969) further pointed out that the ilial protuberance of *Hyla crucifer* is larger than in any other other North American *Hyla*, and is directed laterally rather than dorso-laterally as in the other North American *Hyla* and in the various species of *Pseudacris*.

Goin (1958) presented data on the number of maxillary teeth in certain species of hylid frogs. Among the North American and European members of the genus *Hyla* (excluding *Hyla crucifer*), mean numbers of maxillary teeth ranged from 36.54 (*H. arenicola*) to 60.75 (*H. cinerea*), with a mean of 47.70; while the same counts for *Pseudacris* ranged from 32.00 (*P. streckeri*) to 46.0 (*P. nigrita*) with a mean of 42.20. *Hyla crucifer* has an average of 34.57 maxillary teeth, a number which lies within the range and well below the average mean of the maxillary tooth counts of *Pseudacris* (Figure 2).

External Morphology

In *Hyla* the webbing between the toes is typically well developed, and the toe disc are noticeably expanded. In *Pseudacris*, on the other hand, the webbing is greatly reduced, and the discs barely wider than the digits (see comments by A. P. Blair, et al., 1957; Conant, 1975; Goin, 1961; Jameson and Richmond, 1971; and Noble, 1923. This difference is so consistent, in fact, that it lead Noble (1931) to conclude that "*Pseudacris* ... is merely a group of *Hyla* with reduced web." *Hyla crucifer* agrees with other North American *Hyla* (except, perhaps, some members of the *eximia* group) in having moderately well-developed toe webbing and noticeably expanded discs.

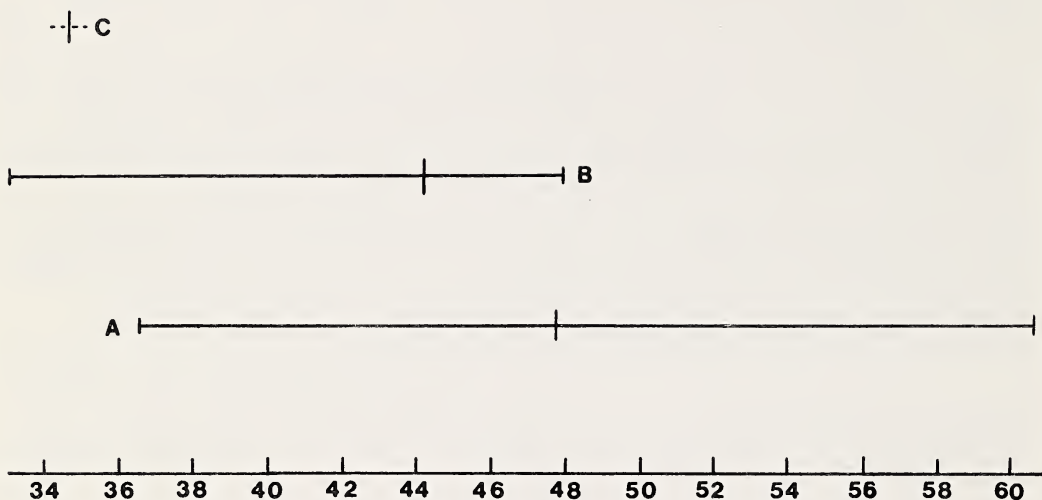


Figure 2. Average maxillary tooth counts for various Holarctic hylid frogs (data from Goin, 1958). A. *Hyla* (11 species). B. *Pseudacris* (12 species and/or subspecies). C. *Hyla crucifer*.

Biochemistry

Leg-muscle protein electropherograms of all of the species of *Pseudacris* and of *Limnaeodius ocularis* are strikingly similar to one another (Figure 3), and all are distinctly different from leg-muscle protein electropherograms of all of the species of North American *Hyla* tested (Figure 4). Simple visual comparisons suggests that, on the basis of leg-muscle proteins, *Hyla crucifer* is more properly aligned with the genus *Hyla* than with genus *Pseudacris*. On the other hand, acrilamide gels of LDH, hemaglobin, and albumin (unfortunately no longer available) suggested a strong similarity between *Hyla crucifer* and members of the genus *Pseudacris*. Although we intend to repeat and expand this study, the work of Keller and Lyster (1977), demonstrating a high degree of LDH polymorphism in *Hyla crucifer*, leaves us less convinced than we had previously been of the usefulness of the electrophoretic technique in dealing with this particular problem. We are convinced, however, that selective use of biochemical

comparisons may ultimately suggest a much closer relationship between *Hyla crucifer* and members of the genus *Pseudacris* than has previously been supposed, and this similarity may indeed tempt future investigators to regard *Hyla crucifer* as a member of the genus *Pseudacris*. Such a conclusion would be unfortunate, however, in that it would require expanding the concept of *Pseudacris* too broadly (to include, possibly, members of the *eximia* group of *Hyla*) or suggest, as has been erroneously suggested several times before, that the genus *Pseudacris* is congeneric with *Hyla*. Both extremes are obviously untenable.

Wallace, Maxson, and Wilson (1971) using albumin immunological distance, presented data suggesting a closer relationship between *Hyla crucifer* and *H. regilla* and *H. cadaverina* (both members of the *eximia* group of *Hyla*) than between *Hyla crucifer* and *Hyla chrysoscelis* (a member of the *versicolor* group). Later Maxson and Wilson (1974) compared the albumin immunological distances of *Pseudacris triseriata* (based on *Hyla regilla* as the reference species) to a number of other hylids. Their study suggests that *Pseudacris triseriata* is more closely related to *Hyla eximia*, *H. euphorbiacea*, and *H. regilla* (all members of the *eximia* group), and *Acris crepitans* than to *Hyla chrysoscelis*, *H. gratiosa*, and *H. femoralis*. The obvious implication of all of this seems to be that there exists a close relationship between members of the *eximia* group of *Hyla*, the genus *Pseudacris*, *Hyla crucifer*, and, perhaps, the genus *Acris*. This does not necessarily imply, however, that these various genera and/or species groups are not of themselves distinct. In a more extensive study of hylid albumins, Maxson and Wilson (1975) place "most of the North American hylines" into a single group, designated Group I. Within this group there are several distinct subgroups, one of which contains most (11) of the North American *Hyla* (including certain members of the *eximia* species group). All *Pseudacris* are placed in a separate subgroup (Subgroup E), two members of the *eximia* species group (*H. regilla* and *H. cadaverina*) are placed together (Subgroup F); and three species, *Hyla arborea*, *H. crucifer* and *Limnaeodius ocularis*, are each placed in a separate, monotypic subgroup. In a separate analysis, based on "organismal classification", most North American hylids, including *Hyla crucifer* and all *Pseudacris* are placed in a single group (Group B. *Hyla* and *Pseudacris*), while *Acris*, *Limnaeodius*, *Osteopilus*, *Pterohyla*, and *Smilisca* are placed in distinct, separate groups. Within the *Hyla* and *Pseudacris* group (Group B), *Hyla crucifer* and *Hyla squirella* are each regarded as *incertae sedis*. Thus in both classifications, but particularly in the classification based exclusively on albumin immunological distance, the uniqueness of *Hyla crucifer* is clearly emphasized.

Bachmann, et al. (1966) have shown similarities in polyploid classes of DNA in liver nuclei of breeding adults of *Hyla crucifer* and three species of *Pseudacris* (*nigrita*, *ornata*, and *triseriata*), but, unfortunately, none of the other species of *Hyla* which they studied were breeding adults so that no general conclusions can be reached.

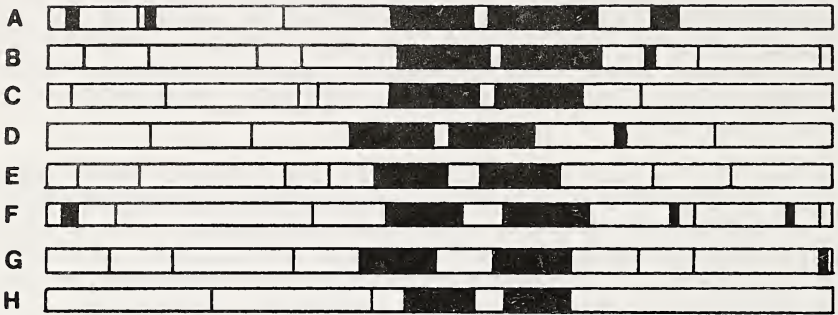


Figure 3. Leg-muscle protein electropherograms of *Limnaeodius* and *Pseudacris*. A. *Limnaeodius ocularis* (n = 9). B. *Pseudacris branchyphona* (n = 4). C. *Pseudacris brimleyi* (n = 12). D. *Pseudacris clarki* (n = 2). E. *Pseudacris nigrata* (n = 7). F. *Pseudacris triseriata* (n = 14). G. *Pseudacris ornata* (n = 5). H. *Pseudacris streckeri* (n = 1).

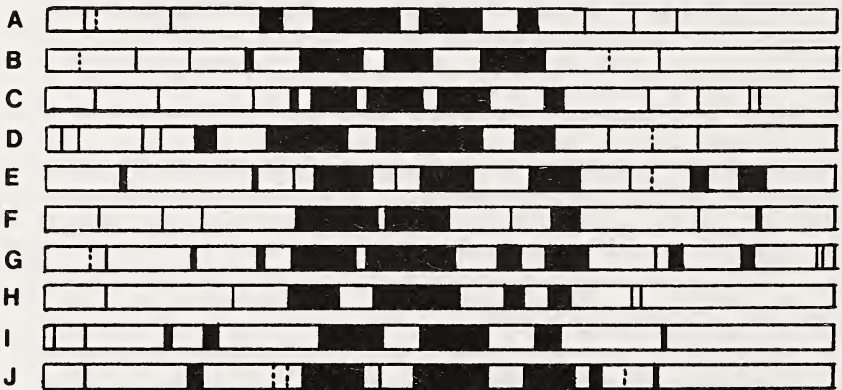


Figure 4. Leg-muscle protein electropherograms of North American *Hyla*. A. *Hyla arenicola* (n = 2). B. *Hyla avivoca* (n = 5). C. *Hyla chrysoscelis* (n = 8). D. *Hyla cinerea* (n = 15). E. *Hyla crucifer* (n = 15). F. *Hyla femoralis* (n = 10). G. *Hyla gratiosa* (n = 7). H. *Hyla regilla* (n = 3). I. *Hyla squirella* (n = 8). J. *Hyla versicolor* (n = 9).

Testes

Both Rugh (1941) and Ralin (1970, 1977) have commented briefly on the presence of dark pigment in the testes of *Hyla crucifer*. Not all individuals of this species have pigmented testes. Oplinger (1966) found three specimens out of 158 (0.019%) with completely white (unpigmented) testes. Except for the genera *Pseudacris*, *Acris*, and *Limnaeodus*, in which, like Ralin (1970), we found pigmented testes in 100 percent of all specimens of all species, we find the presence of pigmented testes to be a highly variable character both intraspecifically (as in *Hyla crucifer* and certain populations of *Eleutherodactylus* now under study) and intragenerically (as in *Hyla* and *Ololygon*). We have examined the testes of 129 hylid species as follows (numbers in parentheses represent the number of species examined in each genus): *Acris* (2), *Amphignathodon* (1), *Anotheca* (1), *Aplastodiscus* (1), *Fritziana* (3), *Gastrotheca* (3), *Hyla* (99), *Hyella* (1), *Limnaeodus* (1), *Ololygon* (10), *Pseudacris* (?). Pigmented testes were found in 27 species representing six of these 11 genera (Table 2). Within the genus *Hyla* pigmented testes are of relatively infrequent occurrence (approximately 11% of the limited number of species examined). It is perhaps worth noting that two of the species having heavily pigmented testes, *Hyla regilla* and *Hyla cadaverina*, are members of the *eximia* species group, a group which has frequently been associated, through various shared characters, with the genus *Pseudacris*. On the other hand, *Hyla squirella*, a species which Blair (1960) associated with the *eximia* group (but which was excluded from this group by Frost, 1985), has unpigmented testes. Based on the occurrence of pigment in the testes of at least some species of *Hyla*, the occurrence of pigmented testes in *Hyla crucifer*, when considered alone, offers no real evidence of any relationship to *Pseudacris*. When considered in relation to other *Pseudacris*-like characters in *Hyla crucifer* and the presence of pigmented testes in all species of *Pseudacris*, the pigmented testes of *Hyla crucifer* strongly suggest a possible close relationship between *H. crucifer* and member of the genus *Pseudacris*.

Dalahoussaye (1966), in his study of sperm morphology, noted that, of seven species of North American *Hyla* which he studied, only the sperm of *Hyla crucifer* possessed a post-helix sheath, a character which it shared with *Pseudacris triseriata*. On this basis he concluded that "*H. crucifer* [may not] bear a very close relationship to other *Hyla*."

Chromosomes

With the exception of the two species of *Acris* and one known polyploid (*Hyla versicolor*) all Holarctic hylids have $2n = 24$ chromosomes (Anderson and Moler, 1986; Bogart, 1973; Bogart and Bogart, 1971; Busnell, et al., 1939; Duellman and Cole, 1974; and Morescalchi, 1973). Wiley (1982) compared secondary constrictions, arm length ratios, and banding patterns of twelve North American hylids belonging to the genera *Hyla* (8 species) and *Pseudacris* (3 species); and was able to arrange these species into species groups based on chromosome morphology. One group contained *Hyla andersoni*, *H. femoralis*, *H. avivoca*, *H. chrysoscelis*, and *H. versicolor*; another *Hyla squirella*, *H.*

gratiosa, and *H. cinerea*; and the last *Pseudacris brimleyi*, *P. triseriata*, *P. ornata*, and *Hyla crucifer*. On the basis of existing data, the chromosomes of *Hyla crucifer* are morphologically more similar to those of *Pseudacris* than to other North American hylids.

Table 2. Hylid frogs in which pigmented testes have been observed.

<u>Species</u>	<u>Origin of Specimen</u>	<u>Comments</u>
<i>Acris crepitans</i>	North Carolina	
<i>Acris gryllus</i>	North Carolina	
<i>Hyla acreana</i>	Brazil	Very heavily pigmented
<i>Hyla avivoca</i>	Mississippi	Faint net-work
<i>Hyla bromelicola</i>	Brazil	Peppered
<i>Hyla cadaverina</i>	California	Very dark
<i>Hyla carnifex</i>	Ecuador	
<i>Hyla crucifer</i>	Illinois	
<i>Hyla labialis</i>	Colombia	Very dark
<i>Hyla marmorata</i>	Ecuador	
<i>Hyla meridionalis</i>	Spain	
<i>Hyla regilla</i>	California	
<i>Hyla semicula</i>	Brazil	
<i>Limnaeodius ocularis</i>	North Carolina	
<i>Ololygon argyreorinata</i>	Brazil	Vesicles very large
<i>Ololygon boulengeri</i>	Ecuador	Peppered
<i>Ololygon fuscomarginata</i>	Brazil	Very dark
<i>Fritziana fissiles</i>	Brazil	
<i>Fritziana ohausi</i>	Brazil	
<i>Fritziana</i> sp.	Brazil	Blotched
<i>Pseudacris brachyphona</i>	West Virginia	
<i>Pseudacris brimleyi</i>	North Carolina	
<i>Pseudacris clarki</i>	Texas	
<i>Pseudacris nigrita</i>	Georgia	
<i>Pseudacris ornata</i>	North Carolina	
<i>Pseudacris streckeri</i>	Texas	
<i>Pseudacris triseriata</i>	Maryland	

Vocalization

The voices of most North American hylids have been described in considerable detail and in numerous papers (for brief descriptions and/or reviews of the voices of individual species see Caldwell, 1982; Conant, 1975; Gaudin, 1979; Martof, 1975; Stebbins, 1966; Wright, 1931; and Wright and Wright, 1949).

From the great amount of available information, one rather surprising observation emerges: "Encounter call" (sometimes called "territorial calls") occur in many species of *Hyla*, particularly in North America; whereas, in *Pseudacris*, encounter calls have been suggested only once (in *P. nigrita*), and then with considerable question.

Among the North American species of *Hyla*, clearly defined encounter calls have been described for *Hyla arenicolor*, *H. chrysoscelis*, *H. cinerea*, *H. crucifer*, *H. gratiosa*, *H. regilla*, *H. squirella*, and *H. versicolor* (Allan, 1973; Ambrey, 1978; W. F. Blair, 1959; Fellers, 1975, 1979; Goin, 1949; Lemon and Struger, 1980; Michaud, 1962; Nussbaum et al., 1983; Oldham and Gerhardt, 1975; Pierce and Ralin, 1972; Rosen and Lemon, 1974; Snyder and Jameson, 1965; Whitney, 1980; and Whitney and Krebs, 1975) and possibly for *Hyla avivoca* (Harper, 1935). Among the numerous papers dealing with vocalization in *Pseudacris* (for example, W. F. Blair, 1958; W. F. Blair and Littlejohn, 1960; Brandt and Walker, 1933; Crenshaw and Blair, 1959; D. F. Hardy, 1959; Harper, 1937; Hoffman, 1980, 1983; Littlejohn and Michaud, 1959; Loftus-Hills, 1974; Lord and Davis, 1956, 1961; Overton, 1914; Smith, 1966; Thompson and Martof, 1957) encounter calls have never been specifically mentioned. Hardy's comments (1959) involving *Pseudacris nigrita* are rather indefinite, and may have involved release calls rather than encounter calls. A definite release call (a call which is functionally quite distinct from an encounter call) has been reported in this species by Martof and Thompson (1958); and McDiarmid and Adler (1974) have pointedly commented that "in *P. nigrita*, there is physical combat *but apparently no territorial vocalization*" (italics are ours).

The trilled encounter call of *Hyla crucifer* is a striking feature of breeding choruses of this species. In this respect *H. crucifer* is more closely similar to other species of *Hyla* than to any of the members of the genus *Pseudacris*.

W. F. Blair (1959) found the call of *Hyla crucifer* sufficiently distinct from the calls of other North American *Hyla* to justify inclusion of this species in a separate, monotypic species group (the *crucifer* group); an arrangement which he subsequently retained in a more detailed study involving morphology, genetic compatibility, and call structure (W. F. Blair, 1962).

Genetic Compatibility

Genetic compatibility of holarctic hylid frogs has been most extensively studied and reviewed by Mecham (1965), Pyburn and Kennedy (1961), and Ralin (1970). Mecham (1965) reported genetic incompatibility between

Hyla crucifer and various species of both *Pseudacris* and *Hyla*, although he postulated a "very low level of hybrid fertility" between *Hyla crucifer* and those species of *Hyla* and *Pseudacris* with which it may be associated in breeding choruses (*Hyla femoralis*, *H. squirella*, and members of the *nigrita*-group of *Pseudacris*). In his diagram showing "potentialities for interspecific gene exchange" (based on a number of kinds of information), *Hyla crucifer* was placed in a distinct and separate group in which only limited gene exchange with some species of *Pseudacris* was implied. Ralin's analysis indicated that, in terms of genetic compatibility, *Hyla crucifer* is equally related to both *Hyla* and *Pseudacris*, although it was generally grouped with members of the *nigrita* and *ornata* groups of *Pseudacris* (Ralin, 1970).

Behavior and Life History

Hyla crucifer is a more arboreal frog than any of the species of *Pseudacris*. Zug (1978) considered all *Pseudacris* to be members of his "Terrestrial II" group, all of which occupy damp or dry terrestrial situations with open or closed canopy. *Hyla crucifer* was placed in the "Arboreal II" group along with various other species which are characteristically found in shrubs or low trees.

As Mecham (1965) and others have pointed out, *Hyla crucifer* breeds much earlier and at much lower temperatures than most other North American species of *Hyla*.

General information on breeding seasons of the North American hylids, as presented in general reviews (Cochran and Goin, 1970; Conant, 1975; Wright and Wright, 1949), can be misleading in that it implies broad seasonal overlap in the breeding seasons of various species of *Hyla* and *Pseudacris* as well as other wide ranging Anuran genera. At specific latitudes, however, *Hyla crucifer* consistently breeds much earlier than those species of *Hyla* with which it occurs sympatrically. Mecham (1965) noted, for example, that in Alabama, *Hyla crucifer* breeds from December to March, while other regional *Hyla* do not begin to breed until late March (*H. avivoca* and *H. versicolor*) and continue breeding into August (*H. avivoca*, *H. versicolor*, *H. squirella*, *H. femoralis*, *H. gratiosa*, and *H. cinerea*). Martof (1960) reported breeding in *H. crucifer* in late September, apparently in response to a passing cold front; otherwise the earliest month reported is November (Wright and Wright, 1949). The earliest breeding dates for all species of *Pseudacris* are in October for *P. streckeri*, and November for *P. ornata*, and at least one member of the genus (*P. triseriata*) may continue breeding until early July in Canada (Blair and Littlejohn, 1960; Harper, 1937; Mecham, 1965; Smith, 1983; Wright and Wright, 1949). Like *Hyla crucifer* and *Pseudacris*, members of the *eximia* group of *Hyla* breed in cold weather. *Hyla regilla*, for example, breeds from November to July (depending on latitude) with peak activity apparently occurring from January to early April (Brattstrom and Warren, 1955; Foster, 1967; Nussbaum, et al., 1983; Snyder and Jameson, 1965; Whitney, 1980; Whitney and Krebs, 1975a, 1975b). In all other North American *Hyla* breeding begins, at the earliest, in March (for example *Hyla arenicolor*, *H. femoralis*, and *H. gratiosa*), and may continue, at least in *H. cinerea* and *H. squirella*,

Into September (Blair, 1958; Harper, 1935; Mecham, 1965; Wright and Wright, 1949).

Calling and/or breeding has been observed in *Pseudacris* at temperatures ranging from 3.0°C in *P. ornata* to 23.0°C in *P. streckeri* (Blair and Littlejohn, 1960; Gerhardt, 1973); and in the latter species the eggs will not hatch at temperatures above 27°C (Hubbs, et al., 1963). In *Hyla crucifer* calling and/or breeding occurs at temperatures between 0.4°C (Gerhardt, 1973) and 24.0°C (Brown and Brown, 1977; Jones and Brattstrom, 1961). Members of the *eximia* group of *Hyla* are also low temperature callers and/or breeders with a minimum reported temperature of 5.0°C in *H. regilla* (Brattstrom and Warren, 1955) and a maximum of 30.0°C in *H. cadaverina* (Ball and Jameson, 1970); although Straughan (1975) noted that, in these two species, females approached males only over a temperature range of 12.9 to 14.7°C. The remaining North American members of the genus *Hyla* are warm temperature breeders: *Hyla versicolor* breeds at a minimum of 17°C (field observations, Lily Pons, Maryland), while *H. gratiosa* breeds at a maximum of 25°C (Blair, 1958).

Typically members of the genus *Pseudacris* call from in or very near the water (Martof and Thompson, 1958; Mittleman and List, 1955; Pyburn and Kennedy, 1960; Schwartz, 1957). *Hyla regilla*, a member of the *eximia* group, may, like *Pseudacris*, call, at low temperatures, with just the head above the water. At higher temperatures, however, it calls from sticks and grass just above the water (Brattstrom and Warren, 1955; Stebbins, 1954; Whitney, 1981). Other North American *Hyla* occupy a variety of call sites, some actually calling from the water (Oldham and Gerhardt, 1975; Wright, 1931; Wright and Wright, 1949). Brown and Brown (1977) found only six out of 25 male *Hyla crucifer* calling while in partial contact with the water; while Gerhardt (1973) found calling males of this species as much as one meter above water.

In *Pseudacris* and *Hyla crucifer* ovulation apparently precedes amplexus; while in most North American *Hyla* (including *Hyla regilla*) ovulation apparently occurs after amplexus (Bragg, 1941; Gosner and Rossman, 1959; Jameson, 1955; Oplinger, 1966).

Hyla crucifer is one of several species of North American *Hyla* in which the eggs are deposited singly (A. P. Blair, 1941; Pague, 1976; Wright and Wright, 1949). In all species of *Pseudacris* the eggs are deposited in masses.

Finally, like certain other species of *Hyla*, *Hyla crucifer* is capable of at least limited color changes (Allen, 1950; Brattstrom and Warren, 1955; Kats and van Dragt, 1986). Such color changes have not been reported in *Pseudacris*.

Comments on the *eximia* Group of *Hyla*

Although there are many similarities between the various species of *Pseudacris* and members of the *eximia* group of *Hyla*, Duellman (1970) has

clearly demonstrated that these species cannot be regarded as congeneric. Significant differences involve osteology, fixed pigment patterns, toe webbing, and the presence or absence of nuptial excrescences and tarsal folds. Osteological differences in the skulls of various members of the genus *Pseudacris* and three members of the *eximia* group of *Hyla* have been well-illustrated several times by Gaudin (1969, 1973b, 1974). There may also be additional differences in developmental stages. Gaudin (1965) noted that the larvae of *Hyla regilla* develop "an opaque layer of deep melanophores that obscure the viscera." This condition has not been observed in *Pseudacris* larvae.

Conclusions

On the basis of the above review we conclude that *Hyla crucifer*, having characteristics of two well-defined genera (*Pseudacris* and *Hyla*), should best be regarded as the only member of a distinct genus for which we suggest the name

Parapseudacris, gen. nov.

Genotype: *Hyla crucifer* Weid 1838

Diagnosis (parenthetical notes indicate whether a specific character is *Pseudacris*-like or *Hyla*-like): More than 10 premaxillary teeth (*Hyla*); number of maxillary teeth reduced, mean 34.57 (*Pseudacris*); sphenethmoid not projected forward between the nasals (*Hyla*); prevomers overlapping and in articulation with sphenethmoid (*Pseudacris*); anterior end of dorsal ridge of urostyle perpendicular to long axis of urostyle (*Hyla*); omosternum more than half length of epicorocoids (*Pseudacris*); mid-point of ilial protuberance anterior to anterior boarder of acetabulum (*Pseudacris*); ilial protuberance large (*Hyla*); ilial protuberance directed laterally, not dorso-laterally (neither *Hyla* or *Pseudacris*); a well-developed ilial ridge (*Hyla*); toe webbing moderately well-developed (*Hyla*); toe discs conspicuously expanded (*Hyla*); leg-muscle proteins *Hyla*-like (*Hyla*); testes heavily pigmented (*Pseudacris*, few *Hyla*); sperm with a post-helix sheath (*Pseudacris*); chromosomes $2n = 24$ (*Hyla* and *Pseudacris*); chromosome morphology *Pseudacris*-like (*Pseudacris*); well-developed encounter call (*Hyla*); cold-water, early-season breeding (*Pseudacris*); amplexus preceeded by ovulation (*Pseudacris*); eggs deposited singly (*Hyla*).

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Fig. 4 In rectilinear locomotion, the snake moves in a straight line.



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The easy-to-read, authoritative text uncovers a great deal of little-known information, including:

* Snakes range in size from 4½ inches to 32 feet. The heaviest snake would undoubtedly be the South American anaconda, *Eunectes murinus*, with a maximum record length of around 30 feet and a probable weight in excess of 330 pounds.

* In India, cobras were believed to be reincarnations of important chiefs and were known as "nagas." They were thought to control rain and other factors and were feared as well as worshipped. In other parts of Asia, snakes were thought as fertility symbols and in Japan the god of thunder was portrayed as a snake.

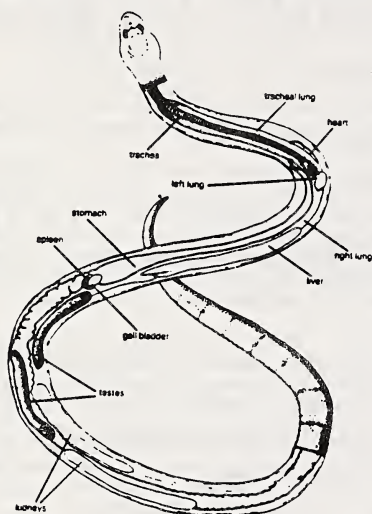


Fig. 6 Sidewinding involves 'throwing' the head and body forward at an angle to the direction of travel.

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Fig. 11 Internal anatomy of a snake (dorsal view) showing the position of the main organs



* Mammals, because of their large size-range and abundance, are widely preyed upon by snakes. Young snakes and small species may be restricted by their size to eating small creatures such as newly born mice, but the giant snakes can deal with mammals up to the size of small wild pigs and deers.

* After mating, male snakes form "copulation plugs." These consist of a mass of waxy material which remains in the cloaca of the female for 2-4 days after mating. Its function is most likely to prevent rival males from mating with the female immediately afterwards and so diluting the sperm from the first male.

* Snakes are found in an almost infinite variety of colors and markings -- hardly any two of the 2,700 or so species are the same.

45

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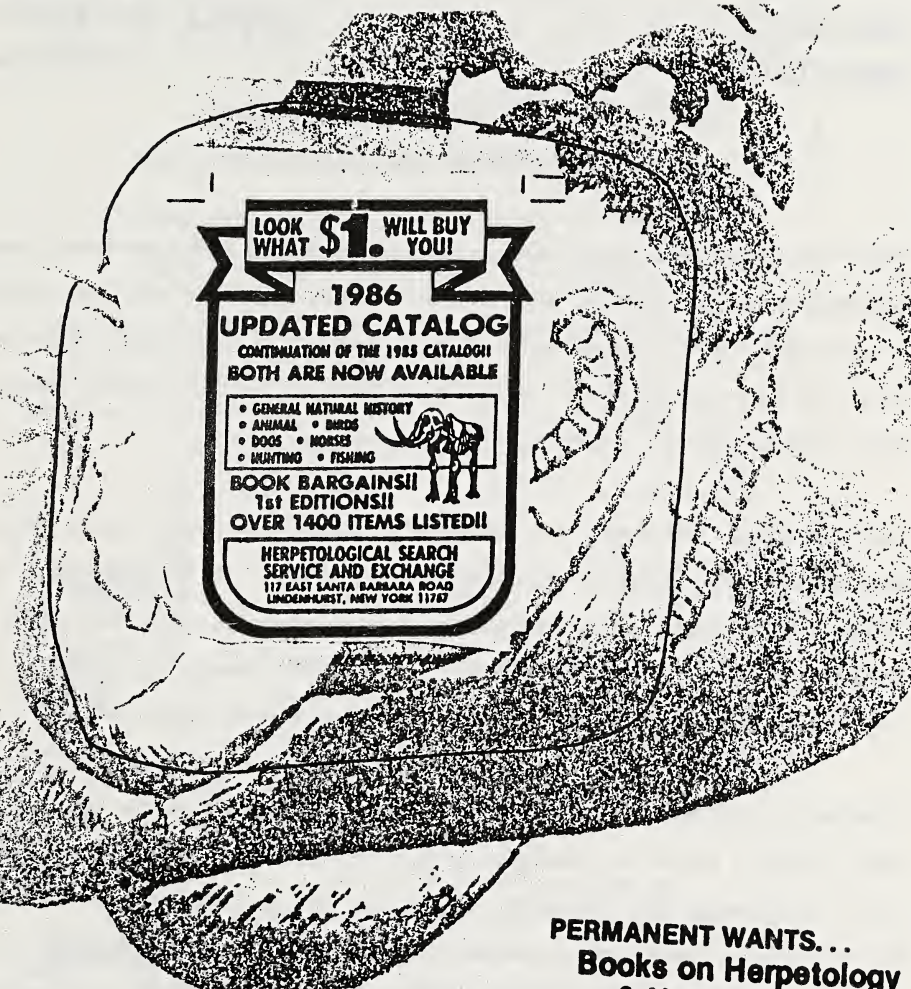
CHRISTOPHER MATTISON is also the author of *The Care of Reptiles and Amphibians in Captivity*. He is a member of both the British and International Herpetological Societies and has lectured on reptile-keeping for over eighteen years.

SNAKES OF THE WORLD, by Christopher Mattison

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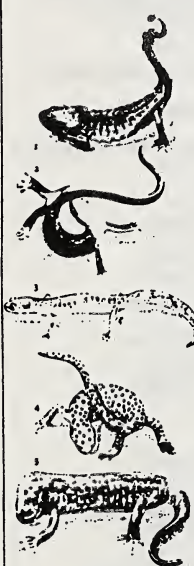
AMPHIBIANS, edited by Dr. Tim Halliday and Dr. Kraig Adler (Publication date: May 6, 1986; Price: \$24.95, hardbound).

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As factually stimulating as it is visually stunning, the ENCYCLOPEDIA offers a host of fascinating herpetological facts, such as:

* All frogs and toads produce poisons from glands in their skin. A few, such as the poison-arrow frogs of South America, deploy some of the



Defensive postures.

- (1) Low-intensity unken reflex in the Spiny newt.
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- (4) Undulating tail posture in the Cave salamander. (5) Head-butting in the Mole salamander.

NOTES:

most deadly biological toxins known -- the Choco Indians of Columbia, in fact, poison the tips of as many of 50 arrows with secretions extracted from one of these tiny frogs.

* Reptiles have one huge advantage over birds and mammals; being less dependent on maintaining a constant body temperature, they can survive on a fraction of the vast food input that birds and mammals require.

* Most snakes eat animals that are large in proportion to their own size. Large prey and their slow metabolism give snakes the advantage of not having to eat so often. Few eat more than once a week, many eat only 8-10 times per year, and a large python can go for 12 months or more without eating.

* In many tropical areas, male frogs join in one of the most impressive of biological phenomena: massive "choruses" where thousands of males from up to 2 dozen species all call at the same time and place for females. For a female, it is a formidable task to find a suitable male of her own species by extracting the proper sound pattern from this cacophony.

* By shuttling between locations of higher and lower temperature, lizards regulate their body temperature, even influencing rates of heat gained while they bask in the sun by making subtle changes in posture to alter the surface area exposed to the sun.

The articles included in the *ENCYCLOPEDIA* were prepared especially by 19 expert contributors, all of whom are actively involved in frontline research on the species and topics they discuss. The inclusion of their latest findings is a unique feature of the book.

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DR. KRAIG ADLER is professor of Biology at Cornell University. He served as President of the Society for the Study of Amphibians and Reptiles in 1982, and was elected first Secretary-General of the World Congress of Herpetology.
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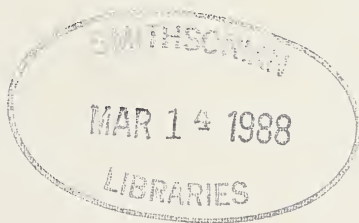
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VOLUME 22 NUMBER 3

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Volume 22 Number 3

September 1986

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September 1986

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DESCRIPTIVE DENTITION MORPHOLOGY OF LIZARDS
OF MIDDLE AND NORTH AMERICA, I:
SCINCIDAE, TEIIDAE, AND HELODERMATIDAE

R. Earl Olson, Bertram Marx, and Robert Rome

Of the small amount of work which has been done in the study of dental morphology in lizards, only a little deals directly with dentition morphology: Owen's "Odontography" (1840-45), an article by Taylor (1940), Hotton's study of Iguanidae (1955), Cooper's work with *Lacerta* (1963), Presch's study of the Teiidae, and Ray's (1965) in certain Iguanids. Certain other studies have appeared from time to time, such as Kingman (1932), Oelrich (1956), Montenucci (1968), and Rocek (1980). However, work has been done on various subjects relative to dentition in reptiles, most of that on tooth replacement. Most prominent in this field are Owen (1840-45), Tomes (1898), Bolk (1922), Parrington (1938), Bogert (1943), Cawston (1943-47), Cooper (1966), and Edmund (1960a & b). Other contributions have been made by such workers as Harrison (1901a & b), Leche (1893), Lynch & Smith (1963), Olson (in press), Peuer (1963), and Woerdeman (1919). The general subject of teeth is dealt with fragmentarily by many authors in their descriptions of families and genera. Boulenger (e.g., 1885) and Cope (e.g., 1900) utilized tooth characters to some extent in their generic descriptions of lizards.

The question of relative age of types of tooth insertion among the Sauria remains unresolved. Camp (1923), in his classification of the lizards, pointed out the lack of uniformity of opinion on this matter. But he was inclined to believe that the fossil record indicates that both pleurodonty and acrodonty have been preceded by thecodonty. Further, he strived to show that thecodonty appears in taxa he considered to be oldest. In the opinion of some workers, palatal teeth are considered to be significant in determination of primitiveness. Camp was persuaded to state: "the simple presence of teeth on the palate (is) paleotelic. Such teeth would seem to be ancestral owing to lack of development in secondary lines of descent and prevalence of teeth in greater numbers in certain more ancient forms." He made no mention, however, of how primitiveness was initially determined, or of the simple or complex structure of the teeth, which may have some significant implications. Such is the inconclusive nature of considered evidence.

The present descriptive study of dentition includes Middle and North American lizard families. The work has a dual purpose: description of the gross surface morphology of teeth in a comprehensive manner, and determination of the relative constancy and nature of variability of teeth within and between taxa. A treatment of the Iguanidae is in final preparation and will follow shortly.

General Considerations

Attachment by ankylosis is a union between the calcified tooth substance and bone of the jaw. The line of attachment is difficult to discern with the naked eye. Tomes (1898) gave the following description of the nature of attachment by ankylosis: "The teeth may be slightly held, so that they break off under the application of but moderate degree of force, or they may be so intimately bound to the bone that a portion of the latter will usually be torn away with the tooth." That special part of the jaw bone ankylosed with the tooth is known as the bone of attachment.

The type of haplodont crown in taxa studied varies only slightly, being straight or recurved to varying degrees. The diconodont crown, when found, (*Crotaphytus* and *Cnemidophorus*) has a small anterior cone and a large main cone. As shown in *Crotaphytus wislizenii*, the crown may be directly posteriorly (fig. 31); it is not in *Cnemidophorus* (fig. 28). The triconodont type varies from just slight rudimental lateral cones on the anterior and posterior side of the main cone, to sharply pointed cones approaching the size of the median cone. These are usually compressed medio-laterally (fig. 31). An extreme type is like that found in *Dipsosaurus* (fig. 8), in which a series of small cones makes up the entire anterior and posterior edges of the crown, forming a finely denticulated crown. This type is compressed and exhibits an anteromedial and posteromedial beveling (fig. 32).

Materials and Methods

Material examined consisted of skeletal (156) or alcoholic (193) specimens. We have endeavored to study completely the surface features of dentition morphology, including the width and medial length of the tooth, type of attachment, characteristics of the crown, and number of teeth found on each bone. For each of these features, we made note of the range of variation and degree of constancy present intraspecifically, interspecifically, intergenerically, and interfamilially.

In order to facilitate the use of measurements and enumeration of characters, and to allow the accumulation of comparable data by others, the methods of counting and measuring teeth which have been employed are stated in detail.

Methods Used in Counting Teeth

All teeth were counted on each tooth-bearing bone present. The number recorded, however, was for only one of any two paired bones. In the case of the premaxilla, the entire tooth content of the bone was recorded. In instances where an unequal number of teeth were present on corresponding bones, both numbers were recorded and included in the average. If the teeth were not present, due to loss during replacement, handling during the preserving procedure, etc., the depression or semi-socket was noted whenever possible. Not infrequently, much difficulty arose in determining the number of teeth that were missing, because of the vague boundaries between the depressions left by the lost teeth. On such occasions where many teeth were

absent, (i.e., maxilla or dentary) the approximate width of the tooth in that specimen was resorted to, in order to determine, as closely as possible, the correct number of teeth.

Reliability of counts: - All of the tooth counts except the palatal are precise, since care was exercised in discerning the vague boundaries of depressions left by missing teeth. In the alcoholic specimens, the teeth were readily studied after the mouth was quickly dried by a jet of compressed air. Understandably, there may be some error in the count for palatal teeth, because their relative minuteness and the great number usually missing makes difficult determination of the almost indistinguishable depressions left by the absent teeth. This error is believed to be insignificant, because of the great variability of these teeth in most species possessing them.

Methods Used in Measuring Teeth

With the exception of several large formes, e.g., *Ctenosaura* (which teeth were measure with dividers), all teeth were measured by use of a monocular, compound microscope (Ernst Leitz), equipped with a 10X, calibrated ocular micrometer and a 4.3X objective. Measurements were recorded in hundredths of a millimeter.

The length of the tooth was measure from the apex of the crown to the base at the point of ankylosis with the jaw. The length was taken on the medial (lingual) side of the tooth, the width at the basal point at which the tooth was entirely free from the bone.

In order to obtain the greatest constancy for comparison of the teeth, the length of the skull was used for establishing ratios, the measurement being from the anterior tip of the premaxilla to the dorsolateral border of the foramen magnum. The skull length was determined by the use of dividers and a millimeter rule. A tooth-size skull length ratio was then recorded.

Reliability of measurements: - Accurate results in measuring were obtained only after considerable practice. The most difficult measurement was the medial length of the tooth. In many instances, the point of ankylosis of the tooth base to the jaw was indistinguishable, making measurement difficult if that particular tooth were in the process of replacement. In such cases, two or three teeth in a row were measured and the largest measurement recorded. Both the small and largest tooth (of any type of crown) on the bone examined were recorded.

In the case of alcoholic specimens, the jaw muscles and coronoid processes were cut. The tongue, together with the hyoid apparatus and connecting muscles, were left intact, but removed from their attachment with the lower jaw. The gums of both upper and lower jaw were removed and the mouth of the specimen quickly dried temporarily with a jet of compressed air. Also, a transverse cut was made on the neck, immediately dorsal to the foramen magnum, in order to measure the skull length.

Collection Designations

FMNH - Field Museum of Natural History

REO - R. E. Olson

UIMNH - University of Illinois Museum of Natural History

USNM - United States National Museum

Family ScincidaeGenus *Eumeces* Wiegmann

Description. Teeth pleurodont, homodont. Haplodont type, conical or spheroid-like crown. Thick, cylindrical shaft. Present on the premaxilla, maxilla, dentary, and pterygoid (?vomerine) bones. A slight beveling is evident on the anterior and posterior sides of crown, toward the medial side. Pterygoid teeth, on ventral median surface smaller and more conical in shape, though irregular in size; in slight depressions usually in one row. Premaxillary teeth separated, right larger than left bone bearing four teeth; left bears only three. Succession typically pleurodont type tendency toward alternate replacement. Teeth directed upward and outward, with slight recurved and compressed crown.

Tooth number is 4 on right premaxilla, 3 on left premaxilla, averages 19 (17-23) on maxilla, 22 (18-26) on dentary, and 5 (4-6) on pterygoid.

Ratio of medial length of tooth to length of skull averages .05 (.05-.06) on premaxilla, .05 (.03-. 0) on dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on premaxilla, and .02 (.01-.04) on dentary.

Variants. Slight ridges were found on the medial surface, just below the crown in some specimens of *Eumeces obsoletus*.

Remarks. Ridges are only detectable with the use of low power on a compound microscope. Processes (usually 2) located on the posterior end of the prevomers are small and resemble the shape of the teeth enough to be called tooth-like. Kingman (1932) considered these tooth-like processes to be the homologue of prevomerine teeth (Taylor, 1935). However, in his 1940 work, Taylor found vomerine "teeth" 1-1 in one specimen of *Eumeces copei*. He added that these processes were not enamel covered. No indication of enamel covering was present in specimens examined during this study. Cope (1900) described these processes as "...appressed hooks, which look downward and backward at the posterior extremities of the bones."

Family TeiidaeGenus *Ameiva* Cuvier

Description. Teeth pleurodont, heterodont. Present on the premaxilla, maxilla, and dentary bones (on pterygoid in one specimen). Crown haplodont, diconodont, and triconodont. Haplodont on entire or on anterior part of premaxilla and first two to four teeth of dentary. Where found on pterygoid, haplodont. Diconodont sometimes on posterior part of premaxilla, first two to seven teeth on maxilla, and third to ninth tooth on dentary. Triconodont usually last ten to eighteen teeth on maxilla, twelve to seventeen teeth on dentary. Little or no transition between types. Crowns of diconodont and triconodont type compressed medio-laterally, only slightly compressed in haplodont type. Replacement typical pleurodont type with tendency for alternate or every other two teeth to be replaced. Diastema present at union of premaxilla and maxilla.

Tooth number averages 9 (7-9) on premaxilla, 19 (17-20) on maxilla, and 23 (22-24) on dentary (2 when present on pterygoid).

Ratio of medial length of tooth to length of skull averages .03 (.03-.04) on premaxilla, .03 (.02-.03) on haplodont portion of dentary, .04 (.03-.06) on diconodont portion of dentary, and .06 (.04-.08) on triconodont portion of dentary. Ratio for width of tooth to length of skull is .01 on premaxilla and haplodont portion of dentary, .01 (.01-.02) on diconodont portion of dentary, and .02 (.01-.02) on triconodont portion of dentary.

Variants. Pterygoid teeth were found present in one specimen of *Ameiva festiva* (UIMNH 11349, Peten, Guatemala).

Remarks. No sign of pterygoid teeth was found in any of the specimens with the exception of the one mentioned above. The pterygoid bone was void of any depressions which might give evidence of the presence of teeth. The specimen in which pterygoid teeth were found was the largest of all examined. Whether this would indicate that only the large animals of the species possess these teeth is uncertain, as no others of that size were available.

Genus *Cnemidophorus* Wagler

Description. Teeth pleurodont to modified pleurodont, heterodont. Present on the premaxilla, maxilla, dentary, and pterygoid bones. Types present are haplodont, diconodont, and triconodont. Haplodont on most or all of premaxilla extreme anterior end of dentary (usually first two to four teeth), and on pterygoid. Diconodont on major portion of maxilla and dentary, rarely on pterygoid (*C. tigris*, UIMNH 33215), near Guaymas, Sonora, Mex.), sometimes on posterior ends of premaxilla. Usually one to five (sometimes up to nine) triconodont teeth on posterior ends of maxilla and dentary. Diconodont and triconodont teeth compressed medio-laterally. Pterygoid teeth usually small, acutely compressed at crowns. Diastema present at union of premaxilla and maxilla.

Diconodont crown composed main cone which is preceded on its anterior side by small cone. Triconodont crown has large central cone, with intermediate-sized cone (much the size of the small cone on diconodont type) on anterior side of tooth, and small cone on posterior side of tooth. Types of teeth change with little or no transition.

Replacement pleurodont type. Teeth have hollow bases. New teeth form in sockets or depression at base of old teeth and grow into larger tooth shaft. Replacement of teeth is irregular; some specimens exhibit a tendency for alternate replacement; several show alternate replacement at posterior and anterior ends of tooth-bearing bones, with every two teeth replacing in center (*C. burti*).

Tooth number averages 7 (5-9) on premaxilla, 19 (16-20) on maxilla, 21 (18-25) on dentary, and 3 (2-5) on pterygoid.

Ratio of medial length of tooth to length of skull averages .03 (.01-.05) on premaxilla, .05 (.03-.08) on diconodont portion of dentary, and .06 (.03-.09) on triconodont portion of dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on premaxilla, .02 (.01-.03) on diconodont portion of dentary, and .02 (.01-.04) on triconodont portion of dentary.

Variants. One specimen of *C. tigris* (UIMNH 33215) was found to be the sole possessor of diconodont teeth on the pterygoid. *Cnemidophorus mexicanus* (UIMNH 23211), near Totolapan, Oaxaca, Mex.) exhibited the presence of all diconodont teeth except the central tooth on premaxilla. Several other specimens were found to have one diconodont tooth on each end of the premaxilla.

Remarks. Type of attachment appears to vary from strict pleurodont to subpleurodont. This variance exists within the genus, within the species, and within the individual itself. In several specimens, the posterior teeth are attached to the apex of the dentary and the maxillary in a semi-acrodont fashion. In rare instances, the smaller specimens exhibit a pleurodont type of attachment and the larger ones a subpleurodont type.

Within the genus, no correlation was found between the type of attachment and the size of the specimen (with the exception noted above). Nor was any correlation found to exist between the attachment and the natural grouping. Indeed, the variation seems to exist equally among the groups. The number of teeth and this ratio overlap extensively, making it extremely impractical to attempt to use these characters in classification of species.

As previously pointed out by Taylor (1940), certain contradictory statements and certain errors have been made over the years. Taylor notes Cope's negligence to mention the palatal teeth in his osteological description of *Cnemidophorus*. He also made reference to Boulenger, concerning the Teiidae, "pterygoid teeth are but seldom present, and if so but feebly developed." Burt (1923) is cited for his error in stating that no palatal teeth exist in *Cnemidophorus*. He also mentioned the ambiguity of

Camp (1923) who stated that the pterygoid teeth are present "in some Teiidae."

In 7 specimens of *Cnemidophorus* examined by Taylor, an average of 5 (2-7) pterygoid teeth were found. We have examined skeletal specimens of this genus and can confirm Taylor's statement of unquestionable existence of such teeth. Presch (1974) said he found pterygoid teeth in *Ameiva ameiva*, *Ameiva bifrontata*, *Callopiastes flavipunctatus*, *Callopiastes maculatus*, *Kentropyx intermedius*, and *Kentropyx calcaratus*, but did not mention them for other macroteiids.

Genus *Gymnophthalmus* Merrem

Description. Teeth pleurodont, homodont, haplodont. Present on the premaxilla, maxilla, and dentary bones. Few posterior teeth show faint suggestion of triconodonty. Crowns very slightly compressed medio-laterally. Typical pleurodont succession with tendency for alternate replacement, though quite irregular.

Tooth number is 6 on premaxilla, 15 to 16 on maxilla, and 18 to 19 on dentary.

Ratio of medial length of tooth to length of skull is .04 on premaxilla, and .05 (.03-.07) on dentary. Ratio for width of tooth to length of skull is .01 on premaxilla, and .02 (.01-.02) on dentary.

Remarks. Boulenger (1885) mentioned the conical teeth of this genus.

Family Helodermatidae

Genus *Heloderma* Wiegmann

Description. Subpleurodont dentition, homodont, haplodont crowns, fang-like with enlarged bases. Crowns compressed acutely. Teeth grooved deeply on anterior side, just buccal to mid-line of tooth. Groove on posterior side not as deep. The grooves appear to be "formed by the inward rolling of the external layer of the crown over the anterior face of the tooth" (Cope, 1900). Posterior groove appears to be an indentation along length of tooth. Teeth longest in mid-portion of maxilla and dentary. Premaxilla teeth considerably smaller than others. All recurved medially and posteriorly and ankylosed to alveolar side of bone at enlarged base. Point of attachment oblique, shape coming from base and lower part of lateral side. Teeth relatively few; spaced relatively far apart. Confined to anterior part of dentary, maxilla and premaxilla. Of two species, *Heloderma suspectum* has no pterygoid-palatine teeth, while *H. horridum* does, according to Cope. However, slight protuberances evident on pterygoid in *Heloderma suspectum*. Replacement appears to be every other or every second tooth. New tooth lies outside base of old tooth. However, unlike Iguanidae, new tooth grows just medio-posteriorly to old tooth. Shafts hollow. (fig. 30)

For *Heloderma suspectum*, tooth number ranges from 6 to 8 on premaxilla, 7 to 8 on maxilla, and 8 to 9 on dentary.

Ratio of medial length of tooth to length of skull ranges from .04 to .06 on premaxilla, and .03 to .04 on dentary. Ratio for width of tooth to length of skull is .02 on premaxilla, and .01 to .04 on dentary.

Remarks. The slight protuberances found on all pterygoid bones examined number from two to four on each bone. The palatine shows no evidence of such protuberances or teeth. Protuberances may be remains of sockets. Boulenger stated that pterygoid and palatine teeth are present in the genus. Taylor (1940) examined three skulls of *Heloderma suspectum* and found much worn pterygoid teeth: 2 (0.2).

SUMMARY OF DATA

Ratios on first line of each species pertain to premaxillary teeth. Ratios on second and third lines of each species refer to dentary teeth. Type of tooth on dentary is indicated in first column. Figures in parentheses represent averages for entire species.

SPECIES	N#	RATIO		NUMBER OF TEETH				
		Ext. and Av. Length/Skull	Ext. and Av. Width/Skull	Premaxilla	Maxilla	Dentary	Pterygoid	Palatine
FAMILY IGUANIDAE								
GENUS ANOLIS								
<i>A. carolinensis</i>	3	.05-.06(.05).01		10-11(10)	19-20(20)	24-25(24)	3(?)	0
haplodont		.03-.06(.04).01-.02(.01)						
triconodont		.05-.08(.07).01-.03(.02)						
<i>A. dumi</i>	4	.04-.05(.05).01		9-11(10)	17-20(18)	21-24(22)	0	0
haplodont		.03-.07(.05).01-.02(.02)						
triconodont		.06-.09(.07).02-.03(.03)						
<i>A. gadovi</i>	2	.04-.05		9-10	20	24-25	0	0
haplodont		.02-.07(.05).01-.02(.01)						
triconodont		.07-.10(.08).02-.03(.03)						
<i>A. l. bourgaei</i>	3	.05-.06(.05).01		10-11(10)	18-22(20)	25-28(26)	0	0
haplodont		.03-.07(.05).01						
triconodont		.05-.10(.08).02-.03(.03)						
<i>A. megapholidotus</i>	2	.05	.02	8-9	20-21	23-24	0	0
haplodont		.04-.06(.05).01-.02						
triconodont		.06-.09(.08).02-.03(.03)						
<i>A. nebuloides</i>	5	.04-.05(.04).01		8-11(9)	20-24(21)	24-26(25)	0	0
haplodont		.02-.07(.05).01-.02(.01)						
triconodont		.05-.11(.08).02-.03(.02)						
<i>A. sericeus</i>	6	.03-.04(.04).01		7-9(7)	18-24(21)	23-28(26)	2-3(?)	0
haplodont		.02-.06(.04).01-.02(.02)						
triconodont		.05-.07(.06).02						
<i>A. l. rodriguezi</i>	2	.03-.04	.01	9	20	22-24	0	0
haplodont		.03-.06(.05).01-.02(.01)						
triconodont		.06-.07(.07).02-.03(.02)						
GENUS CORYTOPHANES								
<i>C. hermandesi</i>	2	.06-.08	.02	7-8	15-19	18-22	4-5	0
haplodont		.03-.06(.05).01-.02						
triconodont		.05-.09(.07).02-.03(.02)						
<i>C. cristatus</i>	2	.05	.02	8	20	22-23	5-6	0
haplodont		.04-.07(.05).01						
triconodont		.06-.09(.07).01-.02						
GENUS LAEMANCTUS								
<i>L. alticoronatus</i>	3	.05-.06(.05).01		8-10(8)	16-18(17)	20-22(22)	3-4-(4)	0
haplodont		.03-.06(.04).01						
triconodont		.04-.10(.07).01-.02(.01)						
<i>L. serratus</i>	4	.06	.01-.02(.01)	8-10(8)	15-17(17)	20-22(21)	2-3-(4)	0
haplodont		.04-.08(.06).01-.02(.01)						
triconodont		.07-.10(.08).01-.03(.02)						
<i>L. deborrei</i>	1	.04	.01	8	20	25	5	0
haplodont		.03-.06(.05).01-.02(.01)						
triconodont		.05-.08(.06).02						
<i>L. longipes</i>	1	.05	.01	7	18	24	5	0
haplodont		.04-.06(.05).01						
triconodont		.07-.09(.08).02						
GENUS BASILICUS								
<i>B. vittatus</i>	6	.05-.06	.01	7-8(8)	18-20(18)	20-23(22)	3-7(5)	0
triconodont		.06-.10(.08).01-.02(.02)						
GENUS IGUANA								
<i>I. rhinolopha</i>	2	.06	.01	7	28	30	5-8	0
GENUS CTENOSAURA								
<i>C. similis</i>	6	.06-.08(.07).01-.02(.02)		6-8(7)	19-26(22)	21-34(28)	10-18(11)	0
haplodont		.03-.11(.06).01-.03(.02)						
triconodont, etc.		.05-.10(.06).01-.02(.02)						
<i>C. canthura</i>	2	.07-.09	.02-.03	7-9	24-25	30-31	14-26	0
haplodont		.04-.10(.06).02						
triconodont, etc.		.05-.08	.02					
<i>C. pectinata</i>	7	.06-.09(.08).02		7	24-28(27)	31-36(34)	14-24(20)	0
haplodont		.04-.09(.07).01-.02(.02)						
triconodont, etc.		.04-.08(.06).01-.02(.02)						
<i>C. hemilopha</i>	4	.05-.07(.06).02		7-8(7)	20-25(23)	21-31(26)	9-30(17)	0
haplodont		.03-.08(.06).01-.02(.02)						
triconodont, etc.		.05-.10(.08).01-.03(.02)						
GENUS ENYALIOSAURUS								
<i>E. quinquecarinata</i>	4	.03-.06(.05).01-.02(.01)		5-7(7)	15-22(18)	19-25(22)	6-12(9)	0
haplodont		.04-.05(.05).01-.02(.01)						
triconodont		.05-.09(.08).02						
<i>E. clarkii</i>	1	.05	.02	5	20	21-24	11-13	0
haplodont		.05	.02					
triconodont		.05-.09	.02					
<i>E. erythromelas</i>	1	.05	.01	6	17	21-22	10	0
haplodont		.05	.01					
triconodont		.04-.08	.01-.02					

SUMMARY OF DATA

Ratios on first line of each species pertain to premaxillary teeth. Ratios on second and third lines of each species refer to dentary teeth. Type of tooth on dentary is indicated in first column. Figures in parentheses represent averages for entire species.

SPECIES	N	RATIO		Premaxilla	NUMBER OF TEETH			
		Ext. and Av. Length/Skull	Ext. and Av. Width/Skull		Maxilla	Dentary	Pterygoid	Palatine
GENUS <i>DIPSOSAURUS</i>								
<i>D. d. dorsalis</i>	5	.04-.05(.04)	.01	6-7(6)	18-20(19)	21-24(22)	4-5(5)	0
triconodont, etc.		.03-.10(.06)	.01-.02(.02)					
GENUS <i>SAUROMALIS</i>								
<i>S. ater</i>	1	.09	.03	5	16-18	18-19	7	?
haplodont		.04-.07	.01-.02					
triconodont, etc.		.04-.09	.03-.04					
<i>S. obesus obesus</i>	4	.07	.01-.02	5	15-18	18-20	7	?
haplodont		.04-.07	.01-.02					
triconodont, etc.		.04-.09	.01-.03(.02)					
GENUS <i>HOLIBROOKIA</i>								
<i>H. m. thermophila</i>	6	.02-.05(.04)	.01-.02(.01)	7	22	27	0	0
haplodont		.05-.07(.06)	.01					
triconodont		.04-.07(.05)	.01-.02(.02)					
<i>H. propinqua</i>	5	.05-.06(.06)	.01	6-7(7)	18-20(19)	23-25(24)	0	0
haplodont		.04-.07(.06)	.01					
triconodont		.06-.07(.07)	.01-.02(.02)					
<i>H. tezzara</i>	5	.03-.04(.04)	.01	6-7(7)	18-22(20)	20-24(23)	0	0
haplodont		.04-.07(.06)	.01					
triconodont		.07	.01-.02(.02)					
GENUS <i>CALLISAURUS</i>								
<i>C. d. ventralis</i>	2	.05-.06	.01-.02	6	19-23	23-24	0	0
haplodont		.04-.08(.06)	.01-.02					
triconodont		.07-.08	.01-.02					
<i>C. d. inusitatus</i>	7	.04-.06(.05)	.01	6-9(7)	20-23(21)	23-24	0	0
haplodont		.06-.07(.06)	.01-.02(.02)					
triconodont		.06-.07(.07)	.02					
GENUS <i>UMA</i>								
<i>U. exsul</i> (paratypes)	2	.06	.01	6	19-20	24	0	0
haplodont		.04-.06	.01-.02					
triconodont		.05-.09(.07)	.01-.02					
<i>U. notata notata</i>	3	.06-.07	.02	6-7	17-20	22-25(23)	0	0
haplodont		.05-.08(.06)	.02					
triconodont		.06-.09(.08)	.02					
<i>U. scoparia</i>	2	.04-.05	.01	5-6	17-21	20-26	0	0
haplodont		.03-.06(.05)	.01					
triconodont		.04-.08(.06)	.01-.02(.02)					
GENUS <i>PETROSAURUS</i>								
<i>P. thalassius</i>	3	.05-.07(.06)	.01	7	19-25(21)	22-29(25)	0	0
haplodont		.05-.07(.06)	.01-.02(.02)					
triconodont		.06-.08(.07)	.01-.02(.02)					
GENUS <i>STREPTOSAURUS</i>								
<i>S. mearnsi</i>	5	.06	.01	5-6(6)	21-22(22)	26-28(27)	0	0
haplodont		.04-.07(.05)	.01					
triconodont		.04-.07(.06)	.01-.02(.02)					
GENUS <i>CROTAPHYTUS</i>								
<i>C. collaris collaris</i>	5	.06	.01-.02(.01)	6-7(7)	15-18(16)	18-22(19)	9-20(13)	4-5(5)
haplodont		.03-.07(.05)	.01-.02(.02)					
triconodont		.04-.07(.06)	.02					
<i>C. reticulatus</i>	2	.06	.02	7	19-20	23	7	5
haplodont		.05	.01-.02					
triconodont		.05-.06	.01-.02					
<i>C. silus</i>	3	.04	.01	6-7(7)	16=18(17)	20-22(21)	6-7(7)	3-4(4)
haplodont		.03-.07(.05)	.01-.02(.01)					
triconodont		.06-.08(.07)	.01-.03(.02)					
GENUS <i>GAMBELIA</i>								
<i>G. w. wislizenii</i>	4	.05	.01	6-7(7)	18-22(20)	22-25(24)	6-7(7)	3-4(4)
diconodont		.06-.07(.07)	.02					
triconodont		.05-.07(.06)	.02					
GENUS <i>PHRYNOSOMA</i>								
<i>P. o. orbiculare</i>	4	.05	.01-.02(.02)	5-6(6)	18	19-21(20)	0	0
haplodont		.04-.08(.06)	.01-.02(.02)					
<i>P. cornutum</i>	4	.04	.01	4-6(5)	15-17(15)	16-19(18)	0	0
haplodont		.04-.06(.05)	.01-.02(.02)					
<i>P. d. douglassii</i>	2	.05	.01-.02	7-8	15-17(16)	19-22(21)	0	0
haplodont		.04-.08(.06)	.01-.02(.02)					
<i>P. bracomieri</i>	1	.04	.01	6	18	20	0	0
haplodont		.03-.05	.01-.02					
<i>P. modestum</i>	5	.03	.01	5-7(6)	16-20(18)	20-24(22)	0	0
haplodont		.03-.04(.04)	.01-.02(.02)					

SUMMARY OF DATA

Ratios on first line of each species pertains to premaxillary teeth. Ratios on second and third lines of each species refer to dentary teeth. Type of tooth on dentary is indicated in first column. Figures in parentheses represent averages for entire species.

SPECIES	N=	RATIO		Premaxilla	NUMBER OF TEETH			
		Ext. and Av. Length/Skull	Ext. and Av. Width/Skull		Maxilla	Dentary	Pterygoid	Palatine
GENUS PHRYNOSOMA (cont.)								
<i>P. p. platyrhinos</i> haplodont	4	.05 .03-.06(.05).	.02 .01-.02(.02)	5-8(7)	14-18(16)	17-21(19)	0	0
<i>P. asio</i> haplodont	4	.04-.06(.05).	.02 .01-.02(.02)	6	17-18(18)	20-22(21)	0	0
<i>P. c. blainvillii</i> haplodont	4	.05 .03-.06(.05).	.01 .01-.02(.02)	5-6(6)	15-18(17)	19-21(20)	0	0
<i>P. solare</i> haplodont	5	.02 .02-.03(.02).	.01 .01	5-6	17-19	21	0	0
GENUS SCELOPORUS (Formosus group)								
<i>S. m. taeniocnemis</i> haplodont	1	.07 .05-.02	.01 .01-.02	6	24	27	0	0
<i>S. m. acanthinus</i> haplodont	1	.07 .04-.07	.01 .01-.02	6	24	26	0	0
<i>S. formosus formosus</i> haplodont	6	.05-.06(.06).	.01 .01-.02(.01)	6	20-22(21)	23-26(24)	0	0
<i>S. asper</i> haplodont	2	.07 .05-.07	.02 .01-.02	6-7	22-24	27-28	0	0
<i>S. stejnegeri</i> (para.) haplodont	2	.06-.07 .04-.07(.06).	.01 .01	5	20-23	25-27	0	0
<i>S. prezygus</i> haplodont	4	.05-.06(.06).	.01 .01	5-7(6)	20-22(21)	21-26(24)	0	0
(Spinosis group)								
<i>S. l. lundelli</i> haplodont	2	.06 .05-.07	.01 .01-.02	5	21-22	24-26	0	0
<i>S. edwardtaylori</i> haplodont	4	.06 .04-.08(.06).	.01-.02(.01) .01-.02(.01)	6	22-23(23)	25-27(26)	0	0
<i>S. m. melanorhinus</i> haplodont	5	.06 .05-.08(.06).	.01-.02 .01-.02(.01)	5-6	21-22	19-25(24)	0	0
<i>S. m. calligaster</i> haplodont	1	.06 .06-.08	.02 .01-.02	6	21-22	23	0	0
<i>S. clarkii clarkii</i> haplodont	2	.06 .03-.06(.05).	.01-.02 .01-.02(.02)	7	22	24	0	0
<i>S. magister magister</i> haplodont	2	.06 .04-.07(.06).	.02 .01-.02	5-6	20-23	23-28	0	0
<i>S. h. horridus</i> haplodont	4	.05-.07(.06).	.01 .01	6-7(6)	22-23(23)	24-27(26)	0	0
<i>S. h. oligoporus</i> haplodont	4	.05-.06(.06).	.01-.02(.01) .01-.02(.01)	5-6(6)	22-23(22)	24-29(26)	0	0
<i>S. spinosus spinosus</i> haplodont	2	.08 .05-.09(.07).	.02 .01-.02	6	22	26-27(26)	0	0
<i>S. olivaceus</i> haplodont	4	.06 .03-.07(.06).	.01 .01	6-7(6)	21-24(23)	24-28(27)	0	0
(Undulatus group)								
<i>S. o. biseriatus</i> haplodont	4	.05-.06(.06).	.01 .01-.02(.01)	6	20-23(22)	23-26(25)	0	0
<i>S. u. consobrinus</i> haplodont	8	.05-.06(.05).	.01 .01-.02(.01)	5-7(6)	20-23(21)	24-27(25)	0	0
<i>S. woodi</i> haplodont	1	.05 .03-.06	.01 .01-.02	6	19	23-24	0	0
(Graciosus group)								
<i>S. g. graciosus</i> haplodont	4	.06 .05-.08(.06).	.01 .01-.02(.01)	5-6(6)	22-23(23)	27-29(28)	0	0

SUMMARY OF DATA

Ratios on first line of each species pertain to premaxillary teeth. Ratios on second and third lines of each species refer to dentary teeth. Type of tooth on dentary is indicated in first column. Figures in parentheses represent averages for entire species.

SPECIES	N	RATIO		Premaxilla	NUMBER OF TEETH			
		Ext. and Av. Length/Skull	Ext. and Av. Width/Skull		Maxilla	Dentary	Pterygoid	Palatine
GENUS <i>SCOLOPORUS</i> (cont.)								
(Grammicus group)								
<i>S. g. grammicus</i>	4	.06-.07(.06)	.01-.02(.01)	5-7(6)	20-22(21)	23-25(24)	0	0
haplodont		.04-.08(.06)	.01-.02(.01)					
triconodont		.06-.09(.08)	.01-.02(.02)					
<i>S. g. microlepidotus</i>	2	.04-.05	.01-.02	6	20-22	25	0	0
haplodont		.04-.08(.06)	.01-.02					
triconodont		.06-.09(.07)	.01-.02(.02)					
<i>S. g. disparilis</i>	4	.05-.06(.06)	.01	6-7(6)	22-24(23)	25-27(26)	0	0
haplodont		.04-.07(.06)	.01					
triconodont		.06-.09(.08)	.01-.02(.02)					
(Megalepidurus group)								
<i>S. megalepidurus</i>	4	.04	.01	5-6(6)	20-21(21)	23-24(24)	0	0
haplodont		.04-.07(.06)	.01-.02(.02)					
triconodont		.06-.08(.07)	.01-.02(.02)					
<i>S. pictus</i>	3	.06	.01-.02(.02)	5-6(5)	18-22(20)	22-25(24)	0	0
haplodont		.03-.08(.06)	.01-.02(.01)					
triconodont		.06-.08(.07)	.01-.02(.02)					
(Torquatus group)								
<i>S. serrifer serrifer</i>	4	.05-.06(.06)	.02	5-6(6)	20-23(21)	23-25(24)	0	0
haplodont		.05-.09(.07)	.01-.02(.02)					
triconodont		.06-.09(.08)	.02					
<i>S. m. mucronatus</i>	4	.06	.01	6	18-21(20)	21-24(23)	0	0
haplodont		.04-.07(.06)	.01-.02(.01)					
triconodont		.06-.08(.07)	.01-.02(.02)					
<i>S. poinsettii</i>	4	.05-.06(.06)	.01-.02(.01)	6	19-20(20)	22-24(23)	0	0
haplodont		.02-.06(.05)	.01-.02(.01)					
triconodont		.04-.08(.07)	.01-.02(.02)					
<i>S. cyanogenys</i>	8	.06-.07(.06)	.02	6	21-24(23)	24-26(25)	0	0
haplodont		.03-.08(.06)	.01-.02(.02)					
triconodont		.05-.08(.07)	.02					
<i>S. t. torquatus</i>	9	.05-.06(.05)	.01	6	20-24(23)	25-28(27)	0	0
haplodont		.04-.07(.05)	.01-.02(.01)					
triconodont		.05-.09(.07)	.01-.02(.02)					
<i>S. lineolateralis</i>	3	.05-.06(.05)	.01	5-6(6)	19-21(20)	22-24(23)	0	0
haplodont		.04-.06(.06)	.01-.02(.01)					
triconodont		.05-.08(.07)	.01-.02(.02)					
<i>S. ornatus ornatus</i>	3	.05-.06(.06)	.01-.02(.01)	5-6(5)	21-22(21)	24-27(25)	0	0
haplodont		.04-.06(.05)	.01-.02(.02)					
triconodont		.04-.08(.07)	.02					
<i>S. dugesii dugesii</i>	3	.06	.01	5-6(6)	21	21-24(23)	0	0
haplodont		.04-.07(.06)	.01-.02(.02)					
triconodont		.05-.09(.07)	.01-.02(.02)					
<i>S. jarrovi jarrovi</i>	8	.06	.01-.02(.01)	5-7(6)	18-23(21)	22-26(24)	0	0
haplodont		.04-.07(.06)	.01-.02(.01)					
triconodont		.05-.09(.07)	.01-.02(.02)					
(Variabilis group)								
<i>S. cozumelae</i>	2	.06	.01	6	18-19	21-23	0	0
haplodont		.04-.08(.06)	.01					
triconodont		.06-.09(.08)	.01-.02(.01)					
<i>S. teapensis</i>	4	.05-.06(.06)	.01	6	21-23(22)	24-27(25)	0	0
haplodont		.04-.07(.06)	.01					
triconodont		.05-.08(.07)	.01-.02(.02)					
<i>S. v. variabilis</i>	3	.06	.01	6-7(6)	20-25(22)	25-28(26)	0	0
haplodont		.04-.07(.06)	.01-.02(.01)					
triconodont		.06-.08(.07)	.01-.02(.02)					
<i>S. v. mazmoratus</i>	4	.06-.07(.06)	.01	6-7(6)	21-24(22)	25	0	0
haplodont		.05-.07(.06)	.01-.02(.01)					
triconodont		.06-.08(.07)	.01-.02(.02)					
<i>S. parvus scutellatus</i>	4	.06-.07(.07)	.02	6-7(7)	19-21(20)	24-26(25)	0	0
haplodont		.05-.08(.07)	.01-.02(.02)					
triconodont		.06-.10(.08)	.01-.02(.02)					
<i>S. couchii</i>	4	.06-.07(.06)	.01-.02(.02)	6-7(6)	19-21(20)	23-25(24)	0	0
haplodont		.03-.07(.06)	.01-.02(.02)					
triconodont		.05-.08(.07)	.01-.02(.02)					
(Maculosus group)								
<i>S. maculosus</i> (para.)	3	.06	.01	6	19	24	0	0
haplodont		.05-.07(.06)	.01					
triconodont		.06-.07	.01-.02					
(Chrysostictus group)								
<i>S. chrysostictus</i>	4	.05-.06(.06)	.01	6-7(6)	22-23(23)	27-30(28)	0	0
haplodont		.03-.08(.06)	.01					
triconodont		.06-.08(.07)	.01-.02(.02)					
(Siniferus group)								
<i>S. s. siniferus</i>	4	.05	.01	6-7(7)	21-25(23)	26-30(28)	0	0
haplodont		.03-.06(.05)	.01					
triconodont		.04-.09(.07)	.01-.02(.02)					
<i>S. squamosus</i>	2	.05	.01	6-8(7)	23	30-31(30)	0	0
haplodont		.03-.07(.06)	.01					
triconodont		.05-.10(.07)	.01-.02(.02)					

SUMMARY OF DATA

Ratios on first line of each species pertain to premaxillary teeth. Ratios on second and third lines of each species refer to dentary teeth. Type of tooth on dentary is indicated in first column. Figures in parentheses represent averages for entire species.

SPECIES	N=	RATIO		Premaxilla	NUMBER OF TEETH			
		Ext. and Av. Length/Skull	Ext. and Av. Width/Skull		Maxilla	Dentary	Pterygoid	Palatine
GENUS <i>SCELOPORUS</i> (cont.)								
<i>(Stiniferus group)</i>								
<i>S. carinatus</i>	2	.05	.01	6	21-24	23-29	0	0
haplodont		.04-.06(.05).01						
triconodont		.05-.08(.07).01-.02(.02)						
<i>S. ochoterenae</i>	2	.05	.01	6	23	27-29	0	0
haplodont		.04-.06(.05).01						
triconodont		.06-.08(.07).01-.02(.02)						
<i>(Utiiformis group)</i>								
<i>S. utiformis</i>	5	.04	.01	5-6(6)	21-28(24)	25-33(28)	0	0
haplodont		.03-.07(.05).01						
triconodont		.06-.08(.07).01-.02(.02)						
<i>(Scalariis group)</i>								
<i>S. jalapae</i>	6	.05-.06(.06).01		6	19-21(20)	23-25(24)	0	0
haplodont		.04-.07(.06).01-.02(.02)						
triconodont		.06-.08(.07).02						
<i>S. aeneus aeneus</i>	3	.05-.06(.06).02		6-7(6)	22-23(23)	24-28(26)	0	0
haplodont		.05-.07(.06).01-.02(.02)						
triconodont		.05-.08(.07).01-.02(.02)						
<i>S. a. bicanthalus</i>	2	.05-.06	.01-.02	7	21-23(22)	25	0	0
haplodont		.06-.07	.02					
triconodont		.06-.09(.08).01-.02(.02)						
<i>S. scalaris scalaris</i>	4	.05	.01	6	22-23(23)	25-27(26)	0	0
haplodont		.03-.07(.05).01-.02(.01)						
triconodont		.05-.08(.07).01-.02(.02)						
<i>(Pyrrhocephalus group)</i>								
<i>S. gadoviae</i>	5	.05-.06(.06).01		6	22-25(24)	28	0	0
haplodont		.04-.09(.07).01-.02(.01)						
triconodont		.06-.09(.08).01-.02(.02)						
<i>S. pyrrhocephalus</i>	2	.04-.05	.01	6	24-25	28	0	0
haplodont		.04-.06(.05).01						
triconodont		.06-.07	.01-.02(.02)					
<i>S. nelsoni</i>	3	.04-.05(.05).01		6	22	22-26(24)	0	0
haplodont		.04-.07(.06).01-.02(.01)						
triconodont		.06-.08(.07).01-.02(.02)						
GENUS <i>SATOR</i>								
<i>S. angustus</i>	3	.05-.06(.06).01-.02(.02)		6	19-23(21)	23-28(26)	0	0
haplodont		.03-.06(.05).01-.02(.01)						
triconodont		.05-.07(.06).01-.02(.02)						
GENUS <i>UPOSAURUS</i>								
<i>(Ornatus group)</i>								
<i>U. ornatus ornatus</i>	3	.05-.06(.05).01		5-6(6)	19	21-24(22)	0	0
haplodont		.03-.07(.06).01-.02(.02)						
triconodont		.05-.08(.07).01-.02(.02)						
<i>(Higricaudus group)</i>								
<i>U. microscutatus</i>	3	.05	.01	6-7(7)	19-22(21)	23-26(25)	0	0
haplodont		.03-.07(.05).01-.02(.02)						
triconodont		.06-.08(.07).01-.02(.02)						
<i>U. gadovi</i>	3	.05-.06(.06).01		6	19-20(19)	24-25(24)	0	0
haplodont		.05-.08(.06).01-.02(.02)						
triconodont		.06-.09(.07).01-.02(.02)						
<i>(Bicarinatus group)</i>								
<i>U. auriculatus</i>	1	.06	.01	6	22	26	0	0
haplodont		.04-.07	.01					
triconodont		.07	.01-.02					
<i>U. b. bicarinatus</i>	3	.05	.01	6-7(6)	19-21(20)	23-24(24)	0	0
haplodont		.04-.08(.06).01-.02(.01)						
triconodont		.07-.10(.08).01-.02(.02)						
GENUS <i>UTA</i>								
<i>U. s. stansburiana</i>	3	.04-.06(.05).01-.02(.01)		6	18-20(19)	23-25(24)	0	0
haplodont		.03-.06(.05).01-.02(.01)						
triconodont		.05-.07(.06).01-.02(.02)						
<i>U. stellata</i>	3	.05-.06(.06).01		6	19-21(20)	26-28(27)	0	0
haplodont		.02-.06(.04).01						
triconodont		.04-.07(.06).02(.02)						
<i>U. taylori</i>	3	.03-.05(.04).01		6	20-23(22)	24-29(26)	0	0
haplodont		.03-.07(.05).01-.02(.01)						
triconodont		.06-.07(.07).02-.03(.02)						
FAMILY SCINCIDAE								
GENUS <i>EUMECES</i>								
<i>E. obsoletus</i>	2	.05-.06	.01-.02	3L-4R	17-19(18)	20-22(21)	4-6	0
haplodont		.03-.10(.06).01-.03(.02)						
<i>E. copei</i>	2	.05	.01	3L-4R	17-21(19)	20-25(22)	4	0
haplodont		.02-.07(.05).01-.02(.02)						
<i>E. fasciatus</i>	2	.05	.01	3L-4R	17-23(20)	18-26(22)	5-6	0
haplodont		.03-.06(.05).01-.02(.02)						

SUMMARY OF DATA

Ratios on first line of each species pertains to premaxillary teeth. Ratios on second and third lines of each species refer to dentary teeth. Type of tooth on dentary is indicated in first column. Figures in parentheses represent averages for entire species.

SPECIES	N=	RATIO		Premaxilla	NUMBER OF TEETH			
		Ext. and Av. Length/Skull	Ext. and Av. Width/Skull		Maxilla	Dentary	Pterygold	Palatine
FAMILY TEIIDAE								
GENUS <i>AMEIVA</i>								
<i>A. undulata parva</i>	3	.04	.01	7-9(8)	17-18(18)	22	0	0
haplodont		.02-.03(.03).01						
diconodont		.04-.05(.05).01-.02(.01)						
triconodont		.04-.08(.07).01-.03(.02)						
<i>A. festiva edwardsi</i>	3	.03	.01	9	19-20(19)	23-24(23)	3(?)	0
haplodont		.02-.03(.03).01						
diconodont		.03-.06(.04).01-.02(.01)						
triconodont		.05-.07(.06).01-.03(.02)						
GENUS <i>CNEMIDOPHORUS</i>								
<i>(Deppii group)</i>								
<i>C. deppii deppii</i>	1	.02-.03	.01	5	20	23	2	0
diconodont		.05-.07 .02						
triconodont		.06-.08(.07).02-.03(.02)						
<i>C. d. lineatissimus</i>	2	.03-.05(.04).01-.02		7-9	20	21	3-5	0
diconodont		.04-.07(.06).01-.02(.02)						
triconodont		.06-.09(.08).02-.04(.03)						
<i>(Sexlineatus group)</i>								
<i>C. sackii communis</i>	8	.02-.03(.02).01		7-9(7)	16-20(18)	18-22(20)	2-4(3)	0
diconodont		.03-.07(.04).01-.04(.02)						
triconodont		.03-.06(.05).02-.03(.02)						
<i>C. sackii bocourdi</i>	1	.02-.03	.01	7	17	21	4	0
diconodont		.04-.07 .02-.03						
triconodont		.03-.06(.05).02-.03(.02)						
<i>C. burti</i> (paratypes)	3	.02-.04(.03).01		7-9(8)	17-19(18)	20-23(21)	2	0
diconodont		.03-.07(.05).01-.02(.02)						
triconodont		.05-.07(.06).02-.03(.02)						
<i>C. sexlineatus</i>	4	.03	.02	7	16-16(16)	19-21(20)	2	0
diconodont		.05-.08(.07).02-.03(.02)						
triconodont		.04-.08(.06).02-.03(.02)						
<i>(Tesselatus group)</i>								
<i>C. tigris aethiops</i>	3	.02-.03(.02).01		7-9(8)	20	24-25(24)	2-4(3)	0
diconodont		.03-.05(.04).01-.02(.02)						
GENUS <i>GYMNOPHTHALMUS</i>								
<i>G. sumichrasti</i>	2	.04	.01	6	15-16	18-19	0	0
haplodont		.03-.07(.06).01-.02(.02)						
FAMILY HELODERMIDAE								
GENUS <i>HELODERMA</i>								
<i>H. suspectum</i>	5	.04-.06(.06).02		6-8(7)	7-8(8)	8-9(9)	0	0
haplodont		.03-.14(.09).01-.04(.03)						

Illustrations

Illustrations are shown of many of the taxa in the study. However, written descriptions of the species of Iguanidae are included in a separate paper. The drawings illustrate morphological variation in tooth types, differences in crown development, and aspects of insertion and spacing of teeth.

The following species are illustrated: Fig. 1) *Anolis lemurinus*, 2) *Corytophanes*, 3) *Laemactus serratus*, 4) *Basiliscus vittatus*, 5) *Iguana iguana*, 6) *Ctenosaura pectinata*, 7) *Enyaliosaurus quinquecarinatus*, 8) *Dipsosaurus dorsalis*, 9) *Sauromalus obesus*, 10) *Holbrookia maculata*, 11) *Holbrookia propinqua*, 12) *Cophosaurus texanus*, 13) *Callisaurus draconoides*, 14) *Uma notata*, 15) *Petrosaurus thalassinus*, 16) *Streptosaurus mearnsi*, 17) *Crotaphytus collaris*, 18) *Crotaphytus wislizeni*, 19) *Phrynosoma asio*, 20) *Sceloporus cyanogenys*, 21) *Sceloporus pyrrhocephalis*, 22) *Sceloporus clarki*, 23) *Sceloporus clarki* right maxilla, 24) *Sator angustus*, 25) *Uta taylori*, 26) *Eumeces copei*, 27) *Ameiva festiva*, 28) *Cnemidophorus sacki*, 29) *Gymnophthalmus sumichrasti*, 30) *Heloderma horridum*, 31 & 32) varying aspects of individual tooth of *Crotaphytus wislizeni* and of *Iguana iguana*.



Fig. 1 - left dentary, *Anolis lemurinus*, near Tapachula, Chiapas, Mex.

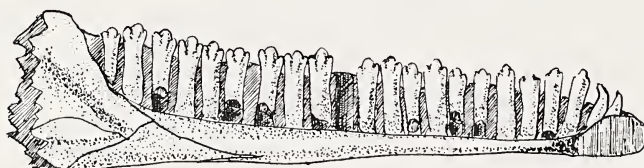


Fig. 2 - left dentary, *Corytophanes percarinatus*, no data.

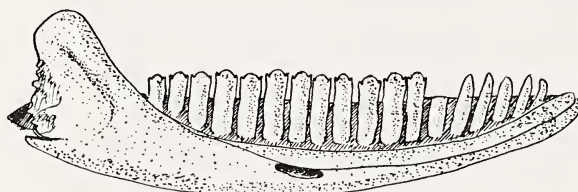


Fig. 3 - left dentary, *Laemanectus serratus*, REO 11452, 3 mi. S Dziuche, Quintana Roo, Mex.

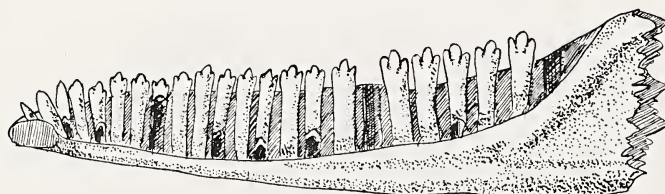


Fig. 4 - right dentary, *Basiliscus vittatus*, REO 5500, 8 mi. W Chetumal, Quintana Roo, Mex.

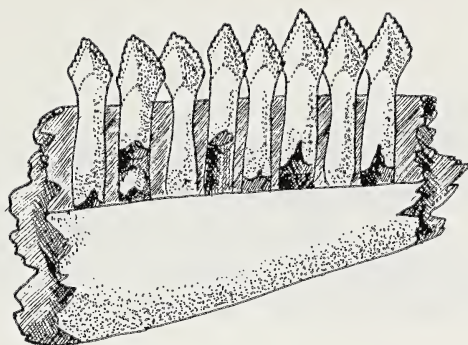


Fig. 5 - ninth to sixteenth teeth on left dentary, *Iguana iguana*, UIMNH S 19855, Piedras Negras, Guatemala.

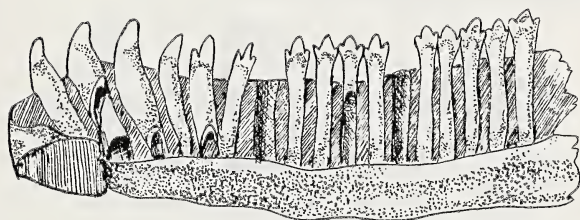


Fig. 6 - portion of right dentary, *Ctenosaura pectinata*, UIMNH S 12318, Tehuantepec, Oaxaca, Mex.

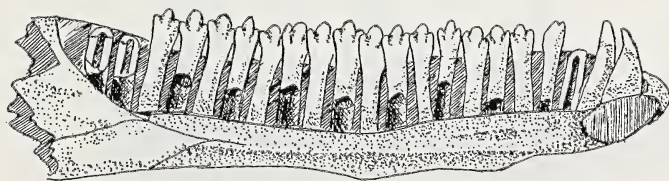


Fig. 7 - left dentary, *Enyaliosaurus quinquecarinatus*, UIMNH S 12471, Tehuantepec, Oaxaca, Mex.



Fig. 8 - left dentary, *Dipsosaurus dorsalis*, REO 4695, 3.3 mi. E Townes Pass, Inyo Co., Calif.



Fig. 9 - left dentary, *Sauromalus obesus*, UIMNH 6030, Palm Springs, Riverside Co., Calif.

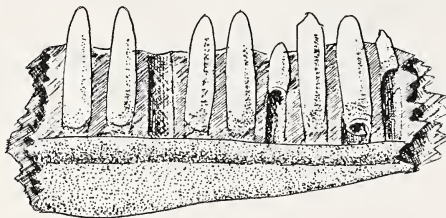


Fig. 10 - tenth to nineteenth tooth on left dentary, *Holbrookia maculata*, UIMNH 33251, 53 mi. S Nogales, Sonora, Mex.

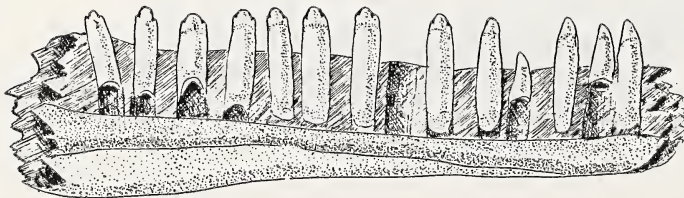


Fig. 11 - tenth to twenty-third teeth on left dentary, *Holbrookia propinqua*, UIMNH 33254, Lexington, Cleveland Co., Oklahoma.

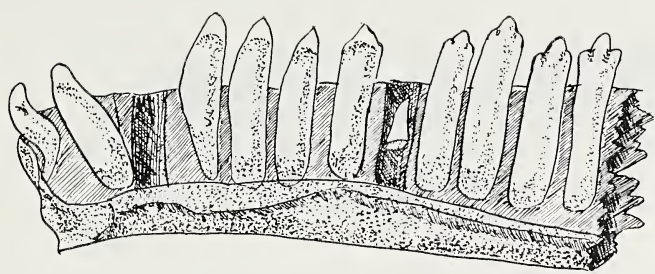


Fig. 12 - portion of right dentary, *Cophosaurus texanus*, UIMNH 33256, no data.

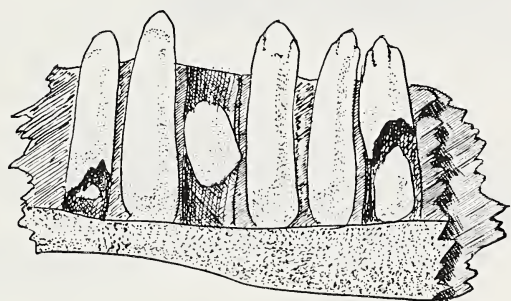


Fig. 13 - thirteenth to eighteenth teeth on right dentary, *Callisaurus draconoides*, UIMNH 33205, 2 mi. W La Posa, near Guaymas, Sonora, Mex.

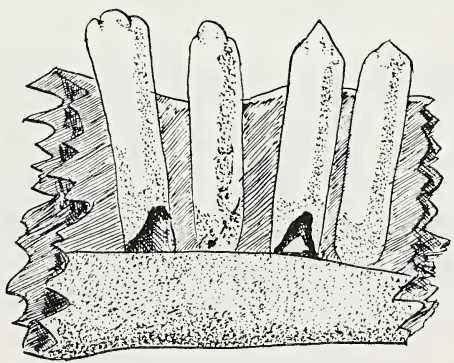


Fig. 14 - fourth to seventh teeth on left dentary, *Uma notata*, FMNH 26180, Imperial Co., Calif.



Fig. 15 - left dentary, *Petrosaurus thalassinus*, USNM 15591, Baja, Calif.



Fig. 16 - left dentary, *Streptosaurus mearnsi*, REO 4624, San Diego Co., Calif.

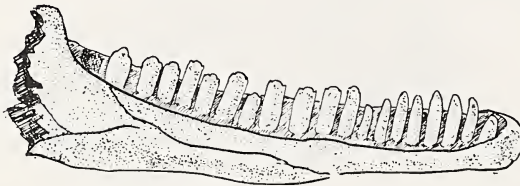


Fig. 17 - left dentary, *Crotaphytus collaris*, near Manhattan, Pottawatomie Co., Kansas.



Fig. 18 - right dentary, *Crotaphytus wislizeni*, UIMNH 1998, 20 mi. W Nephi, Juab Co., Utah.



Fig. 19 - left dentary, *Phrynosoma asio*, Mescalita, Guerrero, Mex.

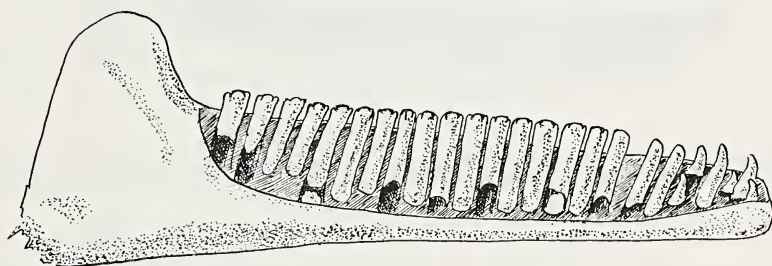


Fig. 20 - left dentary, *Sceloporus serrifer*, REO 2198, 4.5 mi. ESE Rio Grande City, Starr Co., Tex.

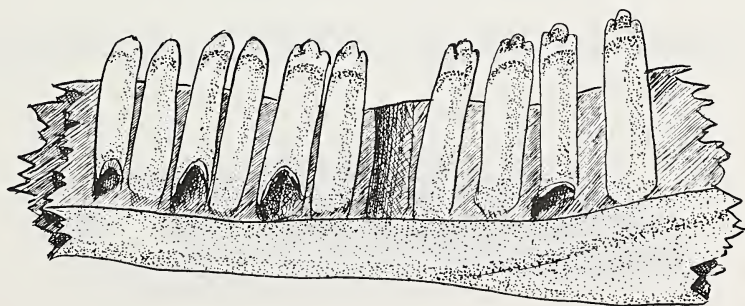


Fig. 21 - portion of right dentary, *Sceloporus pyrrhocephalus*, UIMNH 33286, Paso del Rio, Colima, Mex.

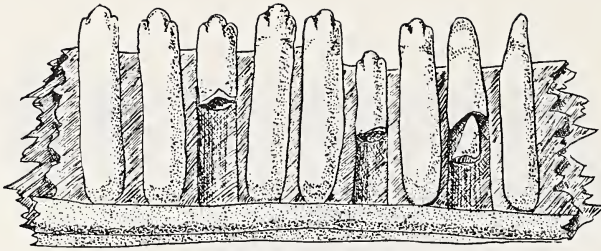


Fig. 22 - seventh to fifteenth teeth on left dentary, *Sceloporus clarki*, UIMNH 23263, 53 mi S Noria, Sonora, Mex.



Fig. 23 - right maxilla, *Sceloporus clarki*, REO 4037, 2 mi. S Portal, Cochise Co., Ariz.



Fig. 24 - left, dentary, *Sator angustus*, USNM 64476, Sta. Cruz Island, Baja Calif.

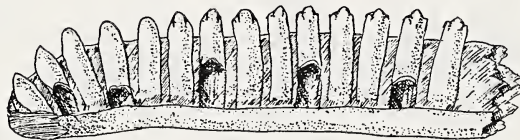


Fig. 25 - portion of right dentary, *Uta taylori*, UIMNH 33328, near San Carlos Bay, 2 mi. W La Posa, near Guaymas, Sonora, Mex.

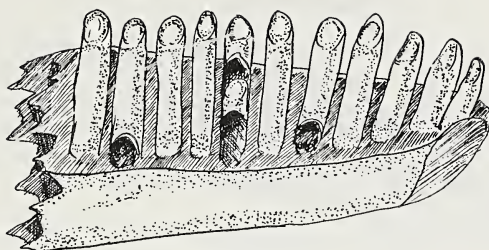


Fig. 26 - portion of left dentary, *Eumeces copei*, UIMNH 33238, Laguna de Zempoala, Morelos, Mex.



Fig. 27 - left dentary, *Ameiva festiva*, UIMNH 11353, Peten, Guatemala.



Fig. 28 - left dentary, *Cnemidophorus sacki*, UIMNH 33211, near Totolapam, Oaxaca, Mex.

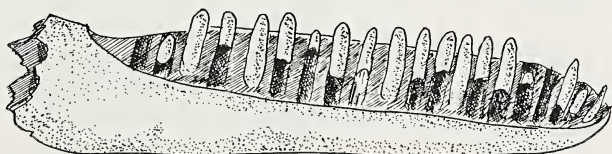


Fig. 29 - left dentary, *Gymnophthalmus sumichrasti*, UIMNH 3763, Escurana, Oaxaca, Mex.

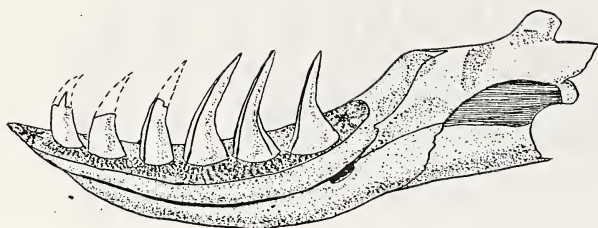


Fig. 30 - right dentary, *Heloderma horridum*, REO, badly damaged specimen, 11 mi. WSW Concordia, Sinaloa, Mex.



Fig. 31 - different tooth crown types in the same jaw; medial views of 5th, 15, and 21st teeth on right dentary of *Crotaphytus wislizeni*, UIMNH 1998.

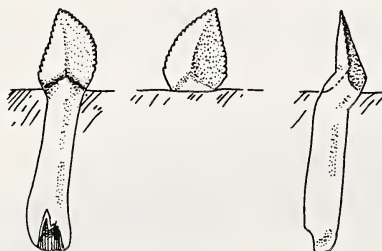


Fig. 32 - medial, lateral, and anterior views of 16th tooth on left dentary of *Iguana iguana*, UIMNH 19855.

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THE STATUS OF THE LOS TUXTLAS (MEXICO) FALSE CORAL SNAKES (*Pliocercus*)

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Abstract

The Los Tuxtlas population of *Pliocercus elapoides* is for the present referred to *P. e. salvini*, although all specimens yet known are unique for the species either by lacking black bands posterior to the neck, or lacking yellow bands; it may constitute a distinct, endemic subspecies.

The bicolor Los Tuxtlas population of *Pliocercus* represents *P. bicolor*, a species limited to México. *P. a. aequalis* occurs in Guatemala, *P. a. euryzonus* in South America and Panamá, *P. a. dimidiatus* in Panamá, Costa Rica, Nicaragua and Honduras. Since *P. aequalis* Salvin, 1861, antedates *P. euryzonus* Cope, 1862, the bicolor superspecies of *Pliocercus* should be known under the former name, which is the nominotypical subspecies when considered conspecific with any other member of the bicolor superspecies.

Five specimens of *Pliocercus* from the Los Tuxtlas region of southern Veracruz are of interest. Four belong to the rare (in México) *aequalis* (formerly *euryzonus*) superspecies (as of Dubois, 1982: 43,57), and one to the common *elapoides* subspecies complex. All throw some light upon the taxonomic status of the two populations occurring in the Los Tuxtlas biotic district.

1. *P. elapoides*. One specimen, UNAM-LT (Los Tuxtlas Herpetological Collection, Universidad Nacional Autónoma de México) 2731, from El Bastonal, Sierra de Santa Marta, 900 m, municipality of Catemaco, taken by G. Pérez-Higareda, has no black rings or bands on either body or tail, except for the nuchal collar; the head is marked as is typical for the species (dark brown from snout to posterior margin of frontal and supraoculars, but entire supralabial border immaculate), however, and a ventral black band occupies the anal plate and two anterior subcaudal scales. The color is uniform red dorsally, throughout body and tail; some of the dorsal scales are black-tipped. Scale counts are: supralabials 8-8, 4th and 5th entering orbit; 8-8 infralabials, 5 in contact with anterior chinshield; 1 loreal, rounded posteriorly; preoculars 3-3; postoculars 2-2; anterior temporals 1-1; scale rows 17 throughout body; 130 ventrals; anal divided.

No reliable differences in scutellation between the *P. aequalis* superspecies and *P. elapoides* are known; the two groups are commonly distinguished by the presence of yellow rings between the black and red rings (or bands) in *P. elapoides*, and their absence in *P. aequalis* (e.g., Peters and Orejas-Miranda, 1970:249). However, that criterion is useless for identification of such anomalous ringless specimens as the present one. The most useful clue has been provided by Greene's (1969:27-30) report of an almost identically-marked specimen, also a female, from rain forest 5.6 mi (by road) ESE of Tebanca, Veracruz, east of Catemaco in the Sierra de Tuxtlas. Two eggs laid by that snake hatched, and although one hatchling was ringless like its mother, the other was ringed and clearly referable to

P. elapoides because of its short (2.5-3 scales) black bands and long (6-10 scales) light interspaces. Although members of the *P. aequalis* superspecies could perhaps include rare ringless anomalies like *P. elapoides*, the geographic coincidence and remarkable similarity of Greene's and the present specimen dictate the most parsimonious assumption that they are conspecific.

Questions nevertheless remain. Typical, tricolor *P. elapoides* is common in the foothills of central Veracruz; on the contrary, every specimen of the species known from the Los Tuxtlas region is either ringless (3) or completely lacks yellow rings (the second, ringed hatchling reported by Greene). Both variations are unique, so far as we are aware, in *P. elapoides*, suggesting that the Los Tuxtlas population of that species may constitute a distinct, endemic subspecies. The abundance of endemism in the Los Tuxtlas region, documented for anurans, salamanders, lizards and snakes, has made it a candidate for recognition as a separate biotic district (Firschein and Smith, 1956:20-21). Fraser (1964) noted the exceptional variability of the endemic coral snake (*Micrurus limbatus*) that he described from Volcán San Martín, which finds a parallel in the *P. elapoides* population of that region. A larger series will be required to demonstrate whether the latter should be regarded as an endemic taxon or not. Until its status can be clarified, it is most appropriate to assign the Los Tuxtlas population to *P. e. salvinii*, to which it most nearly conforms, and which is already known from adjacent Tabasco eastward into Guatemala (Stuart, 1948:71-72) and presumably Honduras (Wilson and Meyer, 1985:80-81). The latter authors, however, recognize no subspecies in *P. elapoides*, because local variation (in Honduras especially, but also elsewhere) is viewed as equalling or exceeding geographic variation.

2. The *P. aequalis* superspecies representatives. Peters and Orejas-Miranda (1970:249-251) recognized four nominal bicolor species, here considered to constitute the *P. aequalis* superspecies: *P. "euryzonus"* Cope, 1862; *P. dimidiatus* Cope, 1865; *P. annellatus* Taylor, 1951; and *P. arubricus* Taylor, 1954. The latter two were described from Costa Rica; *P. dimidiatus* was recorded from Nicaragua, Costa Rica and Panamá, and *P. "euryzonus"* from Veracruz to Colombia, Ecuador and equatorial Brazil. In the latter species the same authors recognized three subspecies: *P. e. euryzonus*, Honduras to South America; *P. e. aequalis* Salvin, 1861, of Guatemala; *P. e. bicolor* Smith, 1941, of México.

We here point out that if the cited subspecies were to be regarded as valid and conspecific, they should be known as subspecies of *P. aequalis*, since that is the oldest nominal taxon of the group: *P. a. aequalis*, *P. a. euryzonus*, and *P. a. bicolor*. The superspecies also thus becomes the *P. aequalis* superspecies.

The only localities of México from which any members of the bicolor group (*P. aequalis*) of *Pliocercus* have hitherto been recorded are Tuxpan, Veracruz (type locality of *P. bicolor*) and Teziutlán, Puebla (Smith, 1941: 123-124; Günther, 1893:106), located in the northern part of their respective states. We here record four more specimens, all adult females, from the municipality of Catemaco in the Los Tuxtlas area: UNAM-LT 2942, from

El Bastonal, Sierra de Santa Marta, 900 m (the same locality from which the ringless *P. elapoides* here reported was taken), Richard C. Vogt and GPH; JJZ (personal collection of Jordi Julià-Zertuche) 190, 193, Cerro Buenavista, 650 m, and Cerro Cintepec, 600 m (to be deposited in the UNAM-LT collection); and UNAM-IB (Instituto de Biología, UNAM), Estación de Biología Tropical "Los Tuxtlas", 160 m. The mountain habitat is tropical rain forest and evergreen oak, with abundant fog and more than 4000 mm annual rainfall. Almost certainly the type locality of *P. bicolor* (Tuxpan) is in error, probably being merely a shipping point, since the species apparently does not occur on the coastal plain.

The three mountain specimens are very much like the holotype of *P. bicolor*, but have slightly fewer and shorter bands on body, fewer of them complete, and slightly longer red interspaces. The black bands are 5 scales long (4-7 in holotype); the red interspaces 5-10 scales long (3-6 in holotype); bands on body and tail 10 + 7 (2) and 12 + 8 (14 on body in holotype, tail rings not noted); 3 (2) and 4 posterior body bands complete ventrally (all complete in holotype). Some dorsal scales in the red interspaces are dark-tipped, but the venter is immaculate. The black rings of the tail are all complete. The black on head extends from the snout completely over the frontal and supraoculars; the supralabial border is black from the 1st to the 5th labials, but the last three are yellow (entire supralabial border yellow in holotype).

The scutellation agrees with that of the holotype: supralabials 8-8, 4th and 5th entering orbit; infralabials 9-9, 5 in contact with anterior chinshields; one loreal, quadrangular; preoculars and postoculars 2-2; anterior temporals 1-1; dorsal scale rows 17 throughout; ventrals 130-134; anal divided.

The single specimen, an adult, from the Biological Station grounds was described by Ramírez-Bautista (1977:137-138), and supplementary information on it was kindly supplied by him and Oscar Sánchez Herrera. There are 17 black rings on body, all but one complete, 5 scales long; 13 black rings on tail; red rings scarcely 2 scales long; head markings and scutellation much like the preceding (notably with 2-2 preoculars), except 8-8 infralabials, 130 ventrals, caudals 101.

The Central and South American subspecies of *P. aequalis* have 23-27 (possibly as few as 20 fide Stuart, 1948:71) dark bands or rings on body (Stuart, 1948:71; Duellman, 1963:242; Wilson and Meyer, 1985:82). On the contrary, all Mexican specimens of the bicolor superspecies of *Pliocercus* have 10-17, and some of the more southern specimens have fewer than the only recorded northern specimen (the holotype of *P. bicolor*). Moreover, in all Mexican specimens the black rings are subequal in length to the red rings, or are longer, whereas in Guatemala material the black rings are much shorter than the red ones (e.g., Duellman, 1963:242, fig. 6A). In the absence of an overlap in character states between Mexican and the adjacent Guatemalan populations, and even of a convergent cline linking Central American and Mexican populations, it seems appropriate to consider the Mexican component as distinct specifically from the more southern bicolor populations. We here

conclude that *P. bicolor* is a valid taxon of species rank, although recognizing that much more material is necessary to clarify definitively the relationships and taxonomic status of the Mexican and its related populations.

The possibility that all of the bicolor species of *Pliocercus* of Central and South America are conspecific with *P. aequalis* was indicated as early as 1982 (Wilson and Meyer, 1982:90; reiterated in 1985:82), in citation of Scott's unpublished dissertation. The same view is implied in the list of the herpetofauna of Costa Rica by Scott, Savage and Robinson (1983:373), in which only "*P. euryzonus*" is included for its genus, even though the nominal species *P. annellatus*, *P. arubricus* and *P. dimidiatus* are also on record elsewhere from there.

Published descriptions, however, indicate very strongly that four species-group taxa exist in the *P. aequalis* superspecies: (1) the *P. bicolor* population of México, with black bands about equal in length to the light interspaces, or longer, and no more than about 17 on body; (2) the *P. aequalis* population of Guatemala, with 20 or more black bands on body, much shorter than interspaces (about half as long; see Duellman, 1963:242, fig. 6A) or, if secondary black bands developed, about equal in length to (or slightly longer than) light interspaces (see Bocourt, 1886:637-638, pl. 41, fig. 7; note especially that 19-25 primary black rings are described encircling the body, and that between them are much shorter secondary black bands, not entirely encircling venter, which would if counted increase the count of total body bands certainly into the 30s; in the specimen illustrated by Duellman (loc. cit.), the secondary bands are indicated merely by dark flecks, hence the interspaces are much longer than in specimens with well-developed secondary bands; in the specimen illustrated by Günther (1893:106, pl. 36, fig. A), presumably the holotype of *P. aequalis*, the secondary bands are indistinguishable from the primary ones, all apparently encircling the body); (3) the population from Honduras into Panamá, with black bands about twice as long as interspaces, or longer, and 23-28 black bands on body; and (4) *P. euryzonus* (sensu stricto) of Panamá and South America, with more than 28 black bands on body, all several times as long as their interspaces. The taxonomic rank of these populations is uncertain, but available evidence indicates that at least *P. bicolor* and *P. aequalis* are allospecific, whereas the three southern populations appear to be conspecific: *P. a. aequalis* of Guatemala, *P. a. euryzonus* of South America and Panamá, and *P. a. dimidiatus* of the Honduras-Panamá region. We agree that *P. arubricus* is simply a variant lacking red pigment, the light interspaces being lavender to white, and that *P. dimidiatus* and *P. annellatus* simply represent normal, variational extremes in number of black bands. The key scale characters used in Peters and Orejas-Miranda (1970:249) are not credible; the 19 midbody scale rows taken as diagnostic of *P. arubricus* actually are counts for the neck (Taylor, 1954:736), and the three preoculars attributed to *P. dimidiatus* do not constitute a character-state usually considered reliable, being generally subject to uncorrelated variation.

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DEVIANT CHARACTERISTICS IN TWO SPECIES OF
MEXICAN BLIND SNAKES AND THEIR BEARING ON THE
PHENOMENON OF ZOOGEOGRAPHIC HYPERHETEROMORPHISM

The unique climatic and ecological conditions of the mountainous region of Los Tuxtlas, southern Veracruz, México, have greatly influenced the herpetofauna of that area. Not all faunal members have been affected, of course, but the incidence of endemism there at the specific and subspecific levels is so high that the region is widely recognized as an unusually distinct biotic district (Firschein and Smith, 1956; Pérez-Higareda and Vogt, 1984).

Indeed, biogeographers tend to evaluate biotic areas largely on the basis of degree of endemism and/or exclusion occurring in them. Yet if the environmental peculiarities of a region, particularly a small, circumscribed one such as the Los Tuxtlas area, are sufficient to result in modifications consonant with differentiation at species-group levels, or higher (assuming that the endemics evolved in situ, whether of relic origin or not), it is reasonable to suppose that those same peculiarities might result also in non-taxonomic variation in some populations. Other populations may appear to be totally unaffected, but it is irrational to expect just the extremes - endemic and unaffected populations - to occur. One should also expect, in dynamic biogeographic areas of small size and minor rank, a recognizably high incidence of deviation from the norm in at least some taxa not limited in distribution to such areas. Such deviation would bridge the gap between the extensive differentiation correlated with species-group endemics, and no differentiation at all. We here designate such deviation as hyperheteromorphism.

Thus, in this scenario, in areas such as described, where a notable proportion of endemics exists, one should expect a certain proportion also of hyperheteromorphic populations of non-endemic species, as well as a large proportion of unaffected populations of non-endemic species.

The phenomenon of hyperheteromorphism would be hard to detect, if it occurs at all, in extensive biotic provinces or regions, and would not be expected in small areas serving exclusively as refugia for relic populations. It should be a distinctive feature, however, of small, dynamic biotic areas such as the Los Tuxtlas district.

The snakes of that district emphatically bear out the hyperheteromorphic rationale. The variability of *Micrurus limbatus* and *Pliocercus elapoides* (without black and/or yellow rings) are already on record (Fraser, 1964; Pérez-Higareda and Smith, 1986), and we here record two other examples, in *Typhlops tenuis* and *Leptotyphlops goudoti phenops*, represented by specimens in the herpetological collection of the Biological Station "Los Tuxtlas" of the Universidad Nacional Autónoma de México (UNAM-LT).

Typhlops tenuis (Salvin)

A uniform light brown or pink-brown color is standard in live specimens of this species, and preserved material becomes light tan with dark brown- or black-spotted scales, as described by Wilson and Meyer (1985:22); a single specimen (UNAM-LT 3016) from Cerro Chochobi, 750 m, Municipality of Catemaco, Veracruz, exhibits unusual characteristics, having a uniform blue-gray coloration and a notable red spot on top of the head. In preservative, the original coloration has become grayish-white, but the scales are immaculate, giving a false impression of albinism. The scale counts are typical, however, except that only one scale occurs ventral to each prenasal (two typically in specimens from Los Tuxtlas); there are 18 scale rows around the body, and 395 middorsal scales (405-407 usually in Los Tuxtlas material).

Leptotyphlops goudoti phenops (Cope)

A dark brown dorsal pattern with distinct longitudinal dark lines is distinctive in this subspecies, as described for example in Wilson and Meyer (1985:20); usually a large white or yellowish spot is present on the tail dorsally and ventrally and another on the head. The tail spot has been considered as an important character in the identification of this subspecies (Orejas-Miranda, in Peters and Orejas-Miranda, 1970:169). With one exception, all material from Los Tuxtlas conforms with those characteristics.

The exception is a specimen from Santa Rosa Cintepec, Municipality of Catemaco, Veracruz, 600 m (UNAM-LT 2283). It is uniformly black, without longitudinal dark lines, superficially resembling *L. dulcis myopicus* (Garman) from northern Veracruz and Tamaulipas, and has only a small subcaudal white spot. However, the scutellation is typical of Los Tuxtlas material: supraoculars much larger than prefrontal; rostral not in contact with supraoculars.

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LIZARDS OF THE KURNOOL DISTRICT,
ANDHRA, INDIA

I. INTRODUCTION

(a) General

Information concerning the herpetology of Andhra is scanty. Apart from some stray records of a few species, Smith (1935) did not give specific consideration to the reptiles of this area as the present State of Andhra was a part of the then composite Madras Presidency till its division in the year 1953. Under the leadership of the Director, Zoological Survey of India, the author has begun a systematic herpetological survey of the districts of Andhra. The present paper deals with 12 species of lizards collected from the plains and forests of Kurnool District in the course of an intensive exploration carried out during December, 1982 through January, 1983.

Several species are recorded in this area for the first time. It is hoped that this work will stimulate further herpetological investigations.

(b) Geography of Kurnool District

The Kurnool District forming part of the Rayalaseema region of Andhra is the largest in the State. It lies between 14° 55' & 16° 20' N and 76° 20' & 79° 36' E. Nearly 25.5% of the geographical area of the district is occupied by forest. The Nallamalas rising up to 900 M are the principal range of hills enveloping dense forests known for their vegetation, fauna, and scenery. The important rivers are Tungabhadra and Krishna. The highest average temperature during the year is 43.8°C and the lowest, 21.7°C. There are about 45 rainy days per year with an average annual rainfall of 635 mm.

II. ACCOUNTS OF SPECIES

Family GEKKONIDAE

1. *Hemidactylus brooki* Gray
Spotted Indian House Gecko

1845. *Hemidactylus brooki* Gray, Cat. Liz. Brit. Mus., P. 153

1935. *H. brooki*: Smith, FBI, 2:89-91

Material. 4 examples, Jagannatha gutta, 3 January 1983.

Diagnosis. Body flattened dorsoventrally; scales on the back granular with rows of trihedral tubercles arranged in regular rows; upper labials 10, lower labials 9; lamellae on the fourth toe 10; tail plump. Male with 12

preano-femoral pores on each side. Snout to vent and tail lengths of the male, 53 mm + 68 mm, of the largest female, 49 mm + 59 mm.

Colour pattern. Dorsally this gecko is dark brown to gray with a series of black spots scattered all over the back. There are two dark streaks on each side of the snout. The belly is white.

Distribution. Known from Borneo and South China through most of tropical Asia and North Africa. A subspecies occurs in the West Indies. The common House Gecko of India.

Habits. Of the four specimens under study two females were found under huge stones and a pair was taken from the loose debris. All the geckos were found living in association with scorpions and beetles. The time of their capture was at 11:30 a.m. Although sunny and getting hot, the lizards remained inactive when picked up.

2. *Hemidactylus gracilis* Blanford

1870. *Hemidactylus gracilis* Blanford, J. Asiat. Soc. Beng. 39:362, pl. 26, figs. 4-6.

1935. *H. gracilis*: Smith, FBI, 2:94.

Material. 7 examples: 3 examples, Kalavabugga, 22 December 1982; 1 example, Sugalmitta, 23 December 1982; 1 example, 28 December 1982, Gorgyapuram; 2 examples, Hatkeshwar, Srisailam (500 M), 11 January 1983.

Diagnosis. Body slender; back with small scales and series of oval, keeled tubercles; upper labials 9, lower labials 7; lamellae on the fourth toe 9. Male with six preanal pores. Snout to vent and tail lengths of the male 38 mm + 41 mm, of the female 31 mm + 33 mm.

Colour pattern. The dorsum is grey with dark brown rectangular spots arranged in two longitudinal rows which are separated by a thin mid streak. The underside is whitish.

Distribution. Smith (loc. cit.) gives the range of this gecko as "S. E. Berar and Raipur, Central Provinces; Bombay Presidency". The specimens under study are, therefore, additional and interesting records from Kurnool District, Andhra and thus they extend the distribution of this species to South India.

3. *Hemidactylus reticulatus* Beddome

1870. *Hemidactylus reticulatus* Beddome, Madras Month. J. Med. Sci. 1:33.

1935. *H. reticulatus*: Smith, FBI, 2:94-95.

Material. 12 examples: 1 example, Gooty Fort, Gooty, 18 December 1982; 4 examples, Kalavabugga, 22 December 1982; 2 examples, Sikharam (510 M), Srisaïlam, 10 January 1983; 5 examples, Hatkeshwar (500 M), Srisaïlam, 11 January 1983.

Diagnosis. Back with erect, keeled granules and enlarged, pointed and keeled tubercles; lamellae on the fourth toe 10. Male with 11 preanal pores. Snout to vent and tail lengths of the adult male 38 mm + 38 mm, of the largest female 35 mm + 35 mm.

Colour pattern. This gecko is brown above with a characteristic pattern of darker lines arranged in a network on the back. The belly is whitish and the throat is speckled with brown. Most of the dorsal tubercles are whitish.

Distribution. Recorded from Madura and Shevaroy, Tamil Nadu, Karnataka and Palkonda Hills. Murthy (1981) recorded this gecko from Kodaikanal, Palnis, Tamil Nadu.

This species is being recorded for the first time from Kurnool District and Srisaïlam in Nallamalas of Andhra.

Habits. Both preceding species were found under loose, small stones in the open hill country of Kurnool District. They were seen living in association with the same sized red scorpions which were also plentiful in the area. The presence of these geckos even at higher elevations up to 500 M in Srisaïlam, Nallamalas indicate that they are not partial to the plains.

4. *Hemidactylus leschenaulti* Dumeril and Bibron
Bark Gecko

1836. *Hemidactylus leschenaulti* Dumeril and Bibron
Erp. Gen. 3:364.

1935. *H. leschenaulti*: Smith, FBI, 2:97-98.

Material. 1 example, Jagannatha gutta, 3 January 1983.

Diagnosis. Body stout with a lateral fold; upper labials 11, lower labials 9. Dorsally head and body covered with fine granules at times intermixed with hemispherical tubercles. Digits rather long; fourth toe with 10 lamellae. Tail strongly depressed. Male with 12 femoral pores on each side. Snout to vent and tail lengths of the single specimen, a male 70 mm + 68 mm.

Colour pattern. It is ashy gray above and silvery white below. Body marked with a vertebral row of 5 rhomboidal spots somewhat shaped like 'W' which break up, however, with age. There is a dark line from eye to ear on each side of the head.

Distribution. Recorded from Tamil Nadu, Kerala, Karnataka, Madhya Pradesh, Rajasthan and West Bengal, India, Sri Lanka, and Pakistan. Smith (loc. cit.) includes Ellore and Palkonda Hills, Andhra in the range of this species. The specimen under study is the first record of this species from Kurnool, Andhra.

Habits. Several individuals of this gecko were found concealed under the bark of a banyan tree where the lizard's colouration merged with the background rendering it almost invisible. When closed, they ran about on the tree trunks but never descended to the ground. They disappeared for some time but emerged under the same bark after a lapse of thirty minutes. The time of capture of the only specimen under study was 11:00 a.m. Besides the Bark gecko, another large arboreal gecko, *Hemidactylus giganteus* was also found on the same tree. Contrary to the statement of Annandale (1906), this gecko frequently enters houses in Madras City as observed by the author.

Family AGAMIDAE

5. *Sitana ponticeriana* Cuvier

Material. 16 examples: 2 examples, Jagannatha gutta, 3 January 1983; 7 examples, Panchamathala Forest, Srisailam (500 M), Nallamalas, 6 January 1983; 7 examples, Srisailam - Dornala Road, 7 January 1983.

Diagnosis. Body compressed. No dorsal crest. Hind feet with 4 toes. No femoral or preanal pores. Tail very long. Male with a gular pouch. Snout to vent and tail lengths of the largest specimen in the series, 45 mm + 105 mm.

Colour pattern. The colour pattern is striking: dark brown dorsally with a vertical series of dark brown, black edged, rhomboidal spots on the back. Majority of the specimens under study have a distinct vertebral line which divides the spots on the back. The ventral side is whitish.

Distribution. The whole of India and Sri Lanka. Annandale (loc. cit.) found it very common throughout Ramnad, Tamil Nadu and the same is true of Kurnool District. The lizard is plentiful in the rocky terrain, scrubby jungles and hills of Kurnool District.

Habits. Several specimens were found beneath stones along with the garden lizard, *Calotes versicolor*. When they were picked up in the cool weather (early January) at Srisailam (500 M), they made no attempt to escape or bite. But the moment they were exposed to the sun, they became very agile by opening up their mouths. Some juveniles were found in a torpid state with their bodies partly covered with loose soil underneath small stones which is probably an adaptation to escape from the prevailing winter.

6. *Calotes versicolor* (Daudin)
Indian Garden Lizard

1802. *Agama versicolor* Daudin, Hist. Nat. Rept. 3:395, pl. 45.

1935. *Calotes versicolor*: Smith, FBI, 2:189-193.

Material. 7 examples: 3 examples, Gooty Lake, Gooty, 19 December 1982; 2 examples, Mahanandi, 24 December 1982; 1 example, Jagannatha gutta, 3 January 1983; 1 example, Panchamathala Forest, Srisailam (500 M), 6 January 1983.

Diagnosis. Body compressed, dorsal scales strongly keeled and more or less larger than ventrals. Two spines separated from each other on ear. Dorsonuchal crest well developed extending far behind. Tail long and rounded. Snout to vent and tail lengths of adult male, 120 mm + 265 mm, of a female 85 mm + 195 mm.

Colour pattern. Juveniles with light dorsolateral stripes which enclose transverse black spots. Adult greyish brown above with dark transverse bars. Belly whitish, with dark streaks. Tail with dark brown cross bars. Head and shoulders of males turn orange or scarlet red. This lizard exhibits considerable colour variation.

Distribution. The commonest lizard of India, Pakistan and Sri Lanka. Also recorded from Sumatra, Hainan, Hong Kong, Afghanistan, Indo-China, South China, northern Malay Peninsula.

Habits. Adult males under study were found hidden behind stems or branches flattening the body laterally until they were almost invisible. Some sleeping and basking individuals were found lying with their body closely pressed against a stem. Some large adults were seen on tree tops situated at 2-3 m above the ground. They became active only after about 11:00 a.m. (late December - early January) when the Sun was at its hottest. In cooler weather at Srisailam they were found beneath stones, their bodies partly concealed by a layer of loose soil.

7. *Psammophilus dorsalis* (Gray)
South Indian Rock-Lizard

1831. *Agama dorsalis* Gray, in Griffith's Anim. King. 9:56.

1935. *Psammophilus dorsalis*: Smith, FBI, 2:210.

Material. 8 examples, Gooty Fort, Gooty, 18 December 1982.

Diagnosis. Body depressed; 120 scales round the body; dorsal crest absent; a deep fold on either side of the neck which unite across the throat. Tail long and slender. No pores. Snout to vent and tail lengths of the largest male 125 mm + 265 mm, of the female 90 mm (tail damaged).

Colour pattern. Young and females are olive brown above with a distinct series of white elongated spots on the back. Adult male brownish retaining only the traces of whitish spots. The underside is yellowish.

Distribution. Hills of Southern India.

8. *Psammophilus blanfordanus* (Stoliczka)

1871. *Charasia blanfordana* Stoliczka, P. Asiat. Soc. Beng; p. 194.

1935. *Psammophilus blanfordanus*: Smith, FBI, 2:210.

Material. 4 examples: 2 examples, Gooty Fort, Gooty, 18 December 1982; 2 examples, Ahobilam Forest, Nallamalas.

Diagnosis. As for the preceding species but with 95 scales around the body. Snout to vent and tail lengths of an adult male, 65 mm + 130 mm, of the female, 55 mm + 105 mm.

Colour pattern. Young and females with a series of lozenge-shaped spots which fade out with age. Adult coloured like *dorsalis*.

Distribution. Bihar, Orissa, Madhya Pradesh, Eastern Ghats, and Kerala. Murthy, et. al. (1980) recorded this lizard from Araku Valley, Eastern Ghats.

Habits. The Common Rock Lizard, *P. dorsalis* was very common and found not only on bare rocks but also inside the ruined structures of the Gooty Fort situated at a height of 200 M. Comparatively the populations of *blanfordanus* seem to be scarce. Although the rock lizards were stout creatures, they were very agile and escaped into a crack or crevice of the rock at the slightest alarm or on approach. After emerging from their hiding places at about 10:30 a.m. and stationing themselves on every available rock, they continued sunning themselves until evening. Occasionally they were found feeding on some ants and other insects. The young and female lizards with their black hues and prominent white spots on the back made an impressive sight on the bare rocks heated by the midday Sun.

Family SCINCIDAE

9. *Mabuya carinata* (Schneider)
Common Skink

1801. *Scincus carinatus* Schneider, Hist. Amph. 2:182.

1935. *Mabuya carinata*: Smith, FBI, 2:266-268.

Material. 1 example, Gorgyapuram, 28 December 1982.

Diagnosis. Head with enlarged scales arranged symmetrically. Body robust, covered with cycloid imbricate scales. Lower eye-lid scaly. Tail fragile. No femoral or preanal pores. Limbs well developed. Snout to vent and tail lengths of a female, 91 mm + 135 mm.

Colour pattern. Young dark bronze above with a yellow lateral band from snout to base of tail. Adults light bronze above with four to six rows of black dots on the back. Two yellowish or whitish stripes on each side of the body. The underside is greenish yellow or white.

Distribution. The whole of India except the northwest and Sri Lanka.

Habits. A pair of the Common Skink was found in the crevices of a huge boulder but unfortunately the female escaped. The "breeding dress" of the male which had scarlet reddish flanks and an yellowish belly confirmed the assumption that the breeding season of this species in Kurnool District might be during December-January.

10. *Lygosoma punctata* (Gmelin)
Dotted Garden Skink

1799. *Scincus punctatus* Gmelin, Hist. Amph., p. 197.

1835. *Riopa punctata*: Smith, FBI, 2:318-319.

1977. *Lygosoma punctata*: Green, J. Nat. Hist., 11:515.

Material. 2 examples, Panchamathala Forest, Srisailam (500 M), 6 January 1983.

Diagnosis. Small and slender. Legs vestigial. Lower eyelid with a transparent cap. Tail very fragile. Snout to vent and tail lengths of a juvenile, 45 mm + 48.5 mm.

Colour pattern. Young with two prominent yellowish dorso-lateral streaks. The dark basal spots on the back are united with each other and form 6 longitudinal lines down the back. The pattern, however, breaks up with age. Tail scarlet red in young (in life) which also fades with age.

Distribution. India and Sri Lanka. Recorded for the first time from Nallamalas, Kurnool District.

Habits. The two specimens under study were collected in a damp, grassy spot. Probably because the weather was cool and wintry (January) the lizards made no attempt to escape.

Family LACERITIDAE

11. *Cabrita leschenaulti* (Milne-Edwards)

1829. *Lacerta leschenaultii* Milne-Edwards, Ann. Sci. Nat. Paris, 16:80,86, p. 6, fig. 9.

1935. *Cabrita leschenaulti*: Smith, FBI, 2:374-375.

Material. 7 examples: 3 examples, Thamarajupalli, 22 December 1982; 4 examples, Sitaramapuram, 26 December 1982.

Diagnosis. Head covered with symmetrical shields; dorsal scales keeled and imbricate while the ventrals are smooth and imbricate. Lower eyelid large, and distinct from the upper eyelid. Tail cylindrical. Femoral pores present. Snout to vent and tail lengths of the largest specimen, 33 mm + 60 mm.

Colour pattern. Dorsally this lacertid is brownish yellow and whitish ventrally. The dorsum is characterized by two white lateral bands, the interval between the two bands being black or green.

Distribution. The Peninsula of India and Sri Lanka. First record from Kurnool District.

Habits. Of the four specimens under study, two examples were taken from stones in a grassy area while the remainder were taken near a thin jungle.

12. *Ophisops jerdoni* Blyth
Snake-Eyed Lacerta

1853. *Ophisops jerdonii* Blyth, J. Asiat. Soc. Beng. 22:653.

1935. *Ophisops jerdoni*: Smith, FBI, 2:377-378.

Material. 6 examples: 2 examples, Ghat Road, 25 December 1982; 4 examples, Hatkeshwar, Srisailam (500 M), 11 January 1983.

Diagnosis. Lower eyelid fused with the upper. A fold in front of the shoulder. Femoral pores present. Snout to vent and tail lengths of the largest adult, 33 mm + 67 mm.

Colour pattern. Dark olive above and whitish below. Two lemon coloured stripes on the flanks which enclose dark transverse bars in the middle zone of the back.

Distribution. Recorded from Gujrat, Punjab, Rajasthan, Madhya Pradesh, Maharastra, Karnataka, India and Pakistan. Beddome (1870) recorded it from Adoni, Kurnool District.

Habits. All the specimens under study were collected under rocks and rubbish. They are found in the rocky terrain and also at higher elevations. They were very wary and darted from one shelter to another, evading all attempts to capture them. Cool weather (January) and the time of day (7:30 a.m.), made collection possible, other they would not have been obtained.

III. SUMMARY

Twelve species of lizards are recorded from the plains and forests of Kurnool District, Andhra for the first time. Besides the systematic notes, natural history observations made in the field were incorporated. This paper constitutes the first major report on the reptile fauna of the hitherto unexplored Rayalaseema region of Andhra.

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THE *Oxyrhopus petola-petolarius* QUESTION CONTINUED

Recently in the pages of this journal Smith, Williams, and Pérez-Higareda (1986:10-13) presented an intricate argument to replace *Coluber petola* L. with *Coluber petolarius* L. of the same date and page Linnaeus (1758:225) as the name of the "Calico False Coral Snake" and hence as the generitype of the genus *Oxyrhopus*.

The argument elaborated by Smith et al. (l.c.) is well presented in the best nomenclatural legalese but it is all beside the point.

Smith et al. (l.c.) state: "the first reviser (Art. 28 of the 1905 edition, Art. 24 of the 1985 edition of the International Code of Zoological Nomenclature) explicitly and by mandate, determines nomenclatural priority...." with which quotation I wholeheartedly agree. In this case the first reviser is Shaw (1802:484) who using the 1766 emendations of the Linnaean names in question presents, under the heading Banded Snake, *Coluber Pethola*, a diagnosis and a brief formal synonymy which includes both Linnaean names, *Coluber Pethola* and *Coluber petalarius* in that order. A description follows and he concludes his account of the species with the statement "The *C. Petalarius* of the Mus. Ad. Frid. can hardly be considered as a species distinct from this."

I cannot explain the lapsus by which I failed to include the Shaw reference in my summary of the genus (1970:232) as it was recorded by me years earlier (1940:130). I can only offer an apology to Smith, Williams and Pérez-Higareda, and to any others inconvenienced by my omission.

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CLUTCH SIZE IN SOME MAINE TURTLES

The following brief report deals with an aspect of the biology of Maine turtles which is relatively unknown; that is clutch size. Clutch size in some turtles, e.g., *Sternotherus odoratus*, has been shown to exhibit latitudinal variation, with the largest clutches coming from females in the more northerly populations (Tinkle, 1961).

During the course of a field inventory conducted in Maine during May and June of 1986, gravid specimens of the Blanding's turtle (*Emydoidea blandingi*), stinkpot (*Sternotherus odoratus*), and wood turtle (*Clemmys insculpta*) were obtained by live trapping. Prior to release at the site of capture, each specimen was measured, marked, and x-rayed to determine oviductal egg count. Species, carapace length, date and location of capture, egg count and egg length and width (range and mean) are given in Table 1.

Although the clutch sizes reported here are well below the maxima reported for *C. insculpta* = 18 (Harding, 1977) and *E. blandingi* = 19 (Brewster, 1982), the egg numbers for the *Sternotherus* are noteworthy for both their mean (= 6.3) and maximum (9). The one clutch of nine equals the record reported for one Michigan female by Tinkle (1961). In addition, the average clutch size for the six Maine specimens in our sample exceeds the Michigan mean of 5.5 also reported by Tinkle (1961). Other information on clutch size in *Sternotherus* includes Risley's report (1933) that clutch size of Michigan females ranged from 2-7, but was usually 3-5. Babcock (1919) stated that clutches in New England contained, 3, 5 or sometimes 7 eggs.

Inspection of Table 1 suggests that clutch size is directly correlated with carapace length in most cases, and a similar direct correlation probably exists between carapace length and mean length and width of oviductal eggs. Tinkle (1961) indicated that the possibility exists that southern *Sternotherus* produce fewer but larger eggs than their northern counterparts. While he did not discuss this possibility further, he did refer to the note by Risley (1933) reporting how nine eggs from a Michigan *Sternotherus* were small in comparison to three larger eggs taken from a much smaller turtle. Such was not the case in the present study. It seems likely that there are larger Maine *Sternotherus* than those we report on here, given our small and isolated sample. If such is the case, we might expect that Maine *Sternotherus* may one day be found with egg counts exceeding the current record of nine.

Acknowledgments

We would like to express our appreciation to the Endangered and Nongame Wildlife Project of the Maine Department of Inland Fisheries and Wildlife and the Natural Heritage Program of the Maine Chapter of The Nature Conservancy for financial support of our field work. We thank Bob Klein for the wood turtle and Janet Graham for technical assistance with the x-ray analysis.

Table 1. Species (SP), date of capture (DOC), location of capture (LOC), location of capture (LOC), carapace length (CL), egg number (EN), and range and mean of egg length (EL) and egg width (EW) for some Maine turtles. All measurements are in mm and egg dimensions were determined directly from x-rays of oviductal shelled eggs.

SP	DOC	LOC	CL	EN	EL	EW
<i>Clemmys insculpta</i>	6-17	Sticky River, Standish, Cumberland, Co.	198.3	11	40.8-44.1(42.7)	23.9-25.1(24.6)
<i>Emydoidea blandingi</i>	6-10	Beaver Dam Pd., Berwick, York County	200.8	12	37.7-40.1(38.6)	24.3-25.7(24.8)
"	"	"	212.2	13	38.4-41.3(39.8)	26.9-27.5(27.2)
<i>Sternotherus odoratus</i>	6-21	Little Watchic Pond, Standish, Cumberland Co.	96.7	5	26.2-26.9(26.6)	15.4-15.8(15.5)
"	6-18	"	97.1	3	26.6-27.7(27.2)	15.3-15.7(15.6)
"	6-18	"	98.5	6	23.5-24.9(24.1)	15.0-15.6(15.4)
"	6-7	"	111.4	7	24.2-25.5(25.1)	15.6-16.3(15.8)
"	6-7	"	112.7	8	25.2-26.3(25.8)	15.5-16.4(16.0)
"	6-11	"	120.8	9	27.6-31.5(30.0)	15.2-17.6(16.8)

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LONGEVITY OF HORNED LIZARDS OF THE GENUS

Phrynosoma

Horned lizards of the genus *Phrynosoma*, although having long been the cherished pets of children in the United States, were considered to be fastidious lizards which usually refused to eat after a short time and therefore died within a few months in captivity.

In recent years, however, several *Phrynosoma* have been successfully maintained and bred in captivity: *P. douglassi* (Montanucci, 1983), *P. solare* (Sherbrooke, 1986) and *P. coronatum jamesi* (Porter, 1982). It is interesting to note that fifty years ago, several German horned lizard keepers had already successfully kept these from three to six years (Klingelhöffer, 1957). Lacking artificial ultraviolet light and proper electric heating they were forced to expose the lizards to natural sun and to let them hibernate at low temperatures.

Maximum life span of horned lizards is rather long. Tanner and Krogh (1973) and also Medica et al. (1973) have longevity records for *P. platyrhinos* of at least 8 years.

About 20 years ago, I became interested in the care and breeding of *Phrynosoma* species in captivity. The results of my work with *P. platyrhinos*, *P. modestum*, *P. asio* and *P. coronatum*/*P. coronatum* x *P. cornutum* have been published elsewhere (Baur 1973, 1979a, 1979b, 1984).

I present here longevity records for some of the *Phrynosoma* species I have maintained. The first two animals mentioned below (*P. modestum*, *P. platyrhinos*) are dead, the others are still living today 18 May 1986.

The following information is included: species name; sex; acquisition (purchase, gift, captive born) and date; initial weight (gms.); initial total length (mm); status (alive or date of death); weight and total length on (date); longevity, yrs./mos./days; remarks.

1. *Phrynosoma modestum*; male; gift, 7 July 1976; 5.1 gms.; 81 mm; killed by dog July 1981; 13.2 gms.; 98 mm on 28 February 1981; longevity: close to 5 yrs.
2. *Phrynosoma platyrhinos*; female; purchase, 2 July 1970; 19.0 gms.; 127 mm; died after hibernation, 24 January 1976; 39.2 gms.; 132 mm on 16 June 1975; longevity: 5 yrs., 6 mos., 22 days; full grown when received.
3. *Phrynosoma asio*; male; purchase, 29 June 1975; 49.8 gms.; 157 mm; alive; 97.6 gms.; 182 mm on 5 April 1986; longevity: 10 yrs., 10 mos., 19 days; half grown when received, probably hatched fall 1973.

4. *Phrynosoma coronatum*; male; gift, 18 April 1979; 37.7 gms.; 144 mm; alive; 65.0 gms.; 153 mm on 24 October 1985; longevity: 7 yrs., 1 mos., full grown when received.
5. *Phrynosoma cornutum*; female; gift, 15 June 1977; 3.8 gms.; 61 mm; alive; 64.6 gms.; 126 mm on 11 June 1985; longevity: 8 yrs., 11 mos., 3 days; probably hatched 1976.
6. *Phrynosoma solare*; male; gift, 9 May 1978; 32.2 gms.; 109 mm on 26 June 1978; alive; 79.2 gms.; 148 mm on 12 May 1985; longevity: 8 yrs., 9 days; half grown when received.
7. *Phrynosoma mcalli*; male; gift, 21 May 1977; 12.8 gms.; 111 mm; alive; 25.5 gms.; 117 mm on 14 September 1985; longevity: 8 yrs., 11 mos., 27 days; full grown when received.
8. *Phrynosoma coronatum* x *P. cornutum*; female; captive born, 28 June 1978; 1.1 gms.; 38 mm; alive; 51.2 gms.; 129 mm on 25 May 1984; longevity: 7 yrs., 10 mos., 20 days; produced young with *P. coronatum* in 1983.
9. *P. coronatum* x (*P. coronatum* x *P. cornutum*); female; captive born, 9 August 1982; 1.1 gms.; 38 mm; alive; 66.2 gms.; 139 mm on 12 April 1985; longevity: 3 yrs., 9 mos., 9 days. Produced eggs in 1985 that failed to hatch. Eggs produced in 1986 looking well after 30 days.

Acknowledgments

I wish to kindly thank Dr. Richard R. Montanucci, Dr. Hobart M. Smith and Karl H. Switak, without their help and encouragement neither these animals would have been kept nor this report been written.

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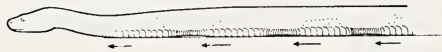
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Fig. 4 In rectilinear locomotion, the snake moves in a straight line.



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* Snakes range in size from $4\frac{1}{2}$ inches to 32 feet. The heaviest snake would undoubtedly be the South American anaconda, *Eunectes murinus*, with a maximum record length of around 30 feet and a probable weight in excess of 330 pounds.

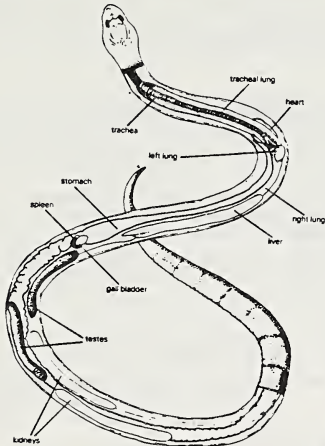
* In India, cobras were believed to be reincarnations of important chiefs and were known as "nagas." They were thought to control rain and other factors and were feared as well as worshipped. In other parts of Asia, snakes were thought as fertility symbols and in Japan the god of thunder was portrayed as a snake.



Fig. 6 Sidewinding involves 'throwing' the head and body forward at an angle to the direction of travel.

NEWS AND NOTES: (cont.)

Fig. 11 Internal anatomy of a snake (dorsal view) showing the position of the main organs.



* Mammals, because of their large size-range and abundance, are widely preyed upon by snakes. Young snakes and small species may be restricted by their size to eating small creatures such as newly born mice, but the giant snakes can deal with mammals up to the size of small wild pigs and deers.

* After mating, male snakes form "copulation plugs." These consist of a mass of waxy material which remains in the cloaca of the female for 2-4 days after mating. Its function is most likely to prevent rival males from mating with the female immediately afterwards and so diluting the sperm from the first male.

* Snakes are found in an almost infinite variety of colors and markings -- hardly any two of the 2,700 or so species are the same.

45

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CHRISTOPHER MATTISON is also the author of *The Care of Reptiles and Amphibians in Captivity*. He is a member of both the British and International Herpetological Societies and has lectured on reptile-keeping for over eighteen years.

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As factually stimulating as it is visually stunning, the ENCYCLOPEDIA offers a host of fascinating herpetological facts, such as:

* All frogs and toads produce poisons from glands in their skin. A few, such as the poison-arrow frogs of South America, deploy some of the



Defensive postures.

- (1) Low-intensity unken reflex in the Spiny newt.
- (2) High-intensity unken reflex in the Red-belly newt.
- (3) Tail-lashing in the ensatina.
- (4) Undulating tail posture in the Cave salamander.
- (5) Head-butting in the Mole salamander.

NEWS AND NOTES: (cont.)

most deadly biological toxins known -- the Choco Indians of Columbia, in fact, poison the tips of as many of 50 arrows with secretions extracted from one of these tiny frogs.

* Reptiles have one huge advantage over birds and mammals; being less dependent on maintaining a constant body temperature, they can survive on a fraction of the vast food input that birds and mammals require.

* Most snakes eat animals that are large in proportion to their own size. Large prey and their slow metabolism give snakes the advantage of not having to eat so often. Few eat more than once a week, many eat only 8-10 times per year, and a large python can go for 12 months or more without eating.

* In many tropical areas, male frogs join in one of the most impressive of biological phenomena: massive "choruses" where thousands of males from up to 2 dozen species all call at the same time and place for females. For a female, it is a formidable task to find a suitable male of her own species by extracting the proper sound pattern from this cacophony.

* By shuttling between locations of higher and lower temperature, lizards regulate their body temperature, even influencing rates of heat gained while they bask in the sun by making subtle changes in posture to alter the surface area exposed to the sun.

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DR. KRAIG ADLER is professor of Biology at Cornell University. He served as President of the Society for the Study of Amphibians and Reptiles in 1982, and was elected first Secretary-General of the World Congress of Herpetology.

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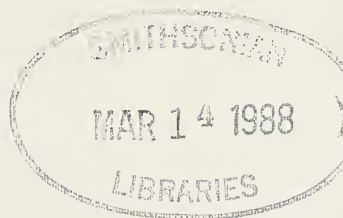


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DECEMBER 1986

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Volume 22 Number 4

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A TAXONOMIC REARRANGEMENT OF THE
SNAKES OF THE GENUS *Scaphiodontophis*

Hobart M. Smith, Kevin Fitzgerald,
Gonzalo Pérez-Higareda and David Chiszar

Abstract

Review of the literature and examination of a unique pattern variant indicate that *Scaphiodontophis* is specifically monotypic, with five subspecies, viz. *S. a. annulatus*, *S. a. dugandi*, *S. a. nothus*, *S. a. venustissimus* and *S. a. zeteki*. A key to subspecies is given, and their possible phylogeny is discussed.

Although *Scaphiodontophis annulatus* (Duméril, Bibron and Duméril, 1854), the "Culebra añadida" of Alvarez del Toro (1982:151), is already well known as one of the most variable snakes in the world, in pattern, we here record another pattern variant differing in nature from all others yet known, discuss its significance, and review the taxonomy of members of *Scaphiodontophis*.

The variations in pattern in this species are so extensive that, when first noted, they were thought to represent six different species, since they seemed then to be largely segregated geographically (*albonuchalis*; *annulatus*, with two subspecies; *carpicinctus*; *cyclurus*; *nothus*; *zeteki*; cf. Taylor and Smith, 1943). Subsequent discovery of sympatry of some of the chromotypes gradually eroded confidence in their distinctions (Martin, 1955:178; Alvarez del Toro and Smith, 1956:13-14), and in 1958 (Alvarez del Toro and Smith, 1958:15-17) all of the chromotypes with a white or yellow ring (instead of a red area) bordering the black head cap posteriorly (*albonuchalis*, *cyclurus*, *nothus*, *zeteki*), were explicitly regarded as synonyms. The name *zeteki*, having priority, was therefore adopted for that nominal species, envisioned as consisting of a northern subspecies (*S. z. nothus*) separate from a southern one (the nominotypical *S. z. zeteki*). At that time the nominal taxa with a red area bordering the black head cap posteriorly were regarded as representing a distinct group of two species (*carpicinctus*, and *annulatus* with two subspecies).

The red-collared group also was destined to reveal itself as a single species, *annulatus*, as more material from Central America became available (Neill and Allen, 1959:47), and indeed Lynch (in Smith and Taylor, 1966:26) had concluded that even the purported subspecies (*hondurensis*, *carpicinctus*) are not tenable.

At that time, then, only two species, *zeteki* and *annulatus*, appeared to be valid, of the original six, with no or weakly differentiated subspecies. The primary distinction remaining between these two nominal

species was envisioned as the presence of a red band or blotch bordering the black head cap posteriorly in *annulatus*, a white (or yellow) ring in *zeteki*.

In 1969 another nominal species was added to that genus: *S. dugandi* Roze, falling into the *annulatus* group, since the black head cap was described as followed by a long red zone.

An unpublished dissertation completed by Morgan in 1973, reviewing all members of the subfamily Sibynophiinae, concluded that even *annulatus* and *zeteki* are synonyms. Morgan found that "the transition from a black nuchal area followed by a yellow band to a red nuchal area followed by black bands enclosing a yellow band takes place on the Yucatán peninsula and in the adjacent lowlands of Guatemala and British Honduras." The red nuchal area pattern extends into Honduras, as described by both Morgan (1973) and Wilson and Meyer (1985:87), whence it is known only on Atlantic slopes, but from numerous specimens. The yellow nuchal band pattern is universal in all material from Mexico (30 specimens, Tamaulipas southward; Colima and Mexico, D.F., records unacceptable) except for Quintana Roo, from the Pacific slopes of Guatemala (8), and from El Salvador (1); Panamá material is the same (3 specimens), but Colombian material (3 specimens) has red following the cranionuchal black region. Nevertheless, the intermediate material from the non-Mexican base of the Yucatán peninsula makes it plain that *annulatus*, the red-necked variety, and *zeteki*, the yellow-necked variety, are conspecific.

Emphasizing the banding peculiarity of *S. dugandi*, to wit the presence of bands on only the anterior part of the body, separated by a long unicolor zone from the completely banded tail, Morgan (1973) synonymized that nominal species also with *S. annulatus*, since one specimen from Panamá had exactly the same distribution of banding. Indeed, Morgan's data make plain that number and distribution of bands are highly variable and show little or no geographic segregation in *S. annulatus*.

Therefore, Morgan's review (1973) concluded that only two species of *Scaphiodontophis* can be recognized--*annulatus* and *venustissimus* (Günther, 1894)--neither with recognizable subspecies. (The unicolor *S. sumichrasti* Bocourt, 1896, included by Taylor and Smith (1943:307) in the genus, had been shown by Guibé and Roux-Estève (1963) to be *Sibynophis collaris* Gray, 1853, of southeastern Asia.) *S. venustissimus* has always been recognized as valid, being distinctive in having banded triads of black bordered by yellow instead of yellow bordered by black as in typical *annulatus*. Morgan (1973) also discovered a diagnostically significant difference in number of subcaudals: *annulatus* ♂118-141 (12), ♀104-134 (19); *venustissimus* ♂103-118 (6), ♀97-104 (6). There is also a distinct difference in subcaudal markings, *annulatus* from México to Honduras and El Salvador having the ends of the subcaudals black-tipped, whereas in *venustissimus* each subcaudal has a large, central black dot. The latter species has generally been regarded as invariably banded throughout the body and tail, whereas *annulatus* is highly variable in this character. Henderson (1982, Brenesia, 19/20:359-362, 1 Fig.; 1984, in Seigel et al., Vertebrate Ecology and Systematics: 185-194, Figs. 1-4) reported a partially banded *venustissimus*, black-speckled gray at midbody, from Costa Rica.

Indeed, the relationship may be closer than formerly assumed, for at least two reasons. For one, there is a strange gap between the ranges of the Panamá/Colombia segment and the Honduras-México segment of *S. annulatus*; no specimens whatever of that taxon are known from the extensive area between central Honduras and eastern Panamá, despite exhaustive collecting in at least Costa Rica. Instead, that hiatus in the range of *S. annulatus* is occupied by *S. venustissimus*, although that species is not yet known from Honduras; 20 are listed for Costa Rica, five for Nicaragua, and two for Panamá in Morgan (1973).

Furthermore, the three specimens from Colombia referred by Morgan (1973) to *S. annulatus* all have a body pattern of single black bands somewhat like *S. venustissimus* (as noted by Morgan, 1973:98, 114), but a tail pattern like *S. annulatus*, as is evident also in Roze's description (1969) of *S. dugandi*. Only the anterior part of the body is banded, to be sure, whereas in most *S. venustissimus* the entire body is banded, but, more importantly, the bands that do exist on the body are single black rings either narrowly bordered by yellow, or bounded by red, thus closely resembling the typical *S. venustissimus* arrangement. The tail in the Colombian specimens, however, bears triads just as in *S. annulatus*: two black bands enclosing a yellow one, with long red bands separating the triads.

Thus it appears that in reality *venustissimus* is most likely a subspecies of (i.e., forms a part of an interbreeding continuum with) *S. annulatus*. Data now available justify recognition of five subspecies: (1) *S. a. nothus*, occurring throughout México except Quintana Roo, on the Pacific slopes of Guatemala, and in El Salvador, and characterized by presence of a yellow neck ring, rather than a red blotch, following the black head cap or black nuchal ring; (2) *S. a. annulatus* of Quintana Roo, Belize, Atlantic slopes of Guatemala, and northeastern Honduras, characterized by presence of a red zone following the black of head or neck; (3) *S. a. venustissimus*, of Nicaragua, Costa Rica, western Panamá and probably eastern Honduras, characterized by yellow-black-yellow triads, separated by red, on both body and tail, and a low subcaudal count (σ 103-118, ? 97-104); (4) *S. a. zeteki* of central and perhaps eastern Panamá as well as adjacent Colombia, with a pattern like *S. a. nothus* but low subcaudal counts (118 σ in only recorded count), a central black spot on each subcaudal, and a light snout; and (5) *S. a. dugandi*, of northeastern Colombia, with single black rings bordered narrowly with yellow or not but separated widely by red zones on anterior part of body, and black-yellow-black triads on tail.

Key to Subspecies of *S. annulatus*

- 1 A. Typically yellow-black-yellow triads, or single red rings, on at least the part of body with red zones; a central black spot on each subcaudal.....2
- B. Typically black-yellow-black triads on body; central black spots on subcaudals, or not.....3

- 2 A. Yellow-black-yellow triads on both body and tail.....*venustissimus*
- B. Yellow-black-yellow triads or single black rings separated only by red zones, only on body (fore part only, so far as known); black-yellow-black triads on tail.....*dugandi*
- 3 A. A red zone bordering black of head or nape posteriorly....*annulatus*
- B. A yellow ring bordering black of head or nape posteriorly...4
- 4 A. Snout dark; subcaudals ♂123-131 (7), ♀104-122 (12); no black spots in center of subcaudals, ends only black tipped.....*nothus*
- B. Snout with extensive light areas; subcaudals ♂118 in only recorded count; a large black spot in center of each subcaudal.....*zeteki*

The phylogeny of these taxa is not readily apparent. Morgan (1973: 114, 188) suggested that the yellow-dark-yellow pattern is derived, stemming from the widespread tendency of right and left halves of the dark-yellow-dark triads to be staggered, and of one of the black bands to be reduced in length. Coincidence of the anterior black ring on one side with the posterior black ring on the other side of any given triad that is split medially, and reduction of the non-contiguous halves of the black bands, would produce a pattern like that of *venustissimus* and on the body of *dugandi*. The assumption conforms with the idea that *zeteki* and *nothus* constitute approximations to ancestral stocks isolated from each other during any of the several inundations of the Panamanian and Tehuantepec portals, and that *annulatus* evolved from the northern isolate after closure of the Tehuantepec portal, as *venustissimus* evolved to the west from *zeteki*, and *dugandi* to the east and south with closure of the Panamanian portal. The shared low number of subcaudals in the latter three taxa (with *dugandi*'s number still a question), and the large black spot on each subcaudal, support the idea of a continuity of origin, just as the higher numbers of subcaudals, and absence of medial black spots on the subcaudals, indicate a genetic continuity of the two more northern subspecies.

Inasmuch as Morgan (op. cit.) regarded the extent of banding on the body and tail as variable, he was not concerned with the seemingly spurious theorizations by Taylor and Smith (1943: 306) and by von Harnack (1953: 546) about the relative antiquity of banding only on the fore part of the body as opposed to banding over the entire body. The absence of bands was regarded as primitive by von Harnack (loc. cit.), and neck banding as an intermediate stage enroute to evolution of complete banding. Taylor and Smith (loc. cit.) regarded neck banding as derived. If, as we have suggested, *zeteki* and *nothus* are approximations to the ancestral form, it seems likely that complete banding is a derived condition, inasmuch as in only one taxon (*venustissimus*) is complete banding nearly invariable. Furthermore, the triads of the latter taxon are thought on other grounds, as noted previously, to be derived. To assume that complete banding is primitive would require assumption of evolutionary reversal to restore the nearly completely unbanded condition.

A specimen (Univ. Colorado Mus. 55742) from near San Pedro Sula, Dept. Cortés, Honduras, captured in April, 1986, recently acquired by William Moss and kept alive for some three months, has a remarkably strange, previously unrecorded pattern (Figures 1, 2) of possible significance in consideration of phylogeny and relationships of the taxa of *S. annulatus*. As described in life, its general dorsal color is brownish gray; from about the level of the 34th ventral, five rows of dark dots extend along the ends of the ventrals and subcaudals, on the 5th and on the median scale rows, one dot on each scale; the ventral surfaces are pinkish white, without markings on either body or tail; a light, pink color suffuses the first scale row. The head is dark above except for a faint light interorbital bar, red patches on sides, and a reddish suffusion over the parietal area. A red collar 3-4 scales long, with black-tipped scales, lies posterior to the parietals, separated by a dark gray zone five scales long from a second red band, three scales long at midline, 6-7 on sides; the following dark gray zone, about six scales long, has a small round black spot, covering four scales, on the right side, and on the left an irregular black spot covering 10-12 scales on its left rear edge; a third red band, three scales long at midline, five at sides, follows the preceding, and posteriorly by another dark gray zone five scales long at midline, 2-3 at sides, with two round black spots, each covering parts of seven scales, positioned centrally and dorsolaterally; a fourth red band follows, 3-4 scales long medially but not reaching the edge of the ventrals as the others do, and with numerous extensively black tips on the more dorsal scales; on the right side the 4th red band has an irregular black border 1-2 scales long; after a following interval of dark gray 2-3 scales long, are three rounded black spots, paravertebral in position, two on the right and one on the left, one covering parts of seven scales (rear right), the others 12 scales.

The specimen is a female, 476 mm s-v, tail 79 mm but incomplete. Scutellation is normal for the species: supralabials 9-9, infralabials 10-10; last supralabial very large; loreals and preoculars single; postoculars 2-2; temporals 1-2-2; scale rows 17-17-17; ventrals about 155; anal divided.

No other specimen of *Scaphiodontophis* has ever been recorded with no yellow rings whatever (although they are weak or absent on the body in *S. a. dugandi*), or with no black rings. If pattern variation were not known to be so extraordinarily great in the genus, the specimen could well be regarded as representative of some other species. However, its scutellation is not distinctive, and as a single specimen with at least some of the basic elements of pattern (rows of black dots on trunk, red banding limited to one part of body) of the known taxa, it seems certainly a variant of *S. annulatus*.

The specimen is said to have been taken in Honduras, and that derivation is likely correct, since other specimens in the same collection represent species common there. More importantly, the subcaudals have no central black spot as is true in the three southernmost subspecies of *S. annulatus* (*venustissimus*, *zeteki*, *dugandi*), ranging from Nicaragua into South America.

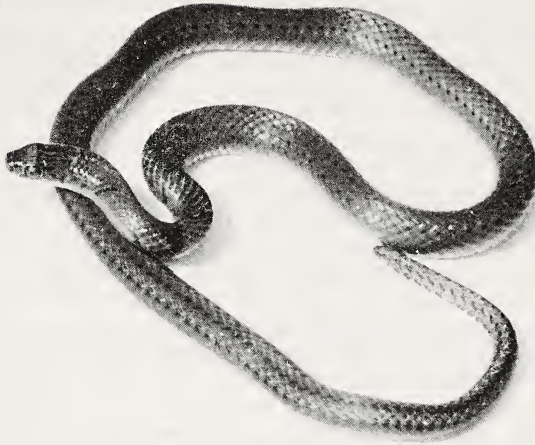


Figure 1. An aberrant, possibly intergrade, female *Scaphiodontophis annulatus*, presumably from northeastern Honduras. Snout-vent length about 476 mm, tail 9 mm (incomplete). Photograph taken with a green filter to emphasize over-all pattern.



Figure 2. Head and neck of the same specimen illustrated in Figure 1. Photograph taken with a red filter.

In the absence of both yellow and black bands, the specimen cannot be interpreted as atavistic, due to relative antiquity of the two patterns of triads in the genus.

The behavior of the live snakes is of interest. As noted by Alvarez del Toro (1982:153), it is totally inoffensive, never attempting to bite. It has an extraordinary initial reaction to handling, however, strongly twitching the body where touched, as though attempting to dislodge a predator or other unwanted intruder. With continued gentle handling the reaction ceases or is reduced in frequency and energy. The animal has a strong aversion to bright light, and is not strongly thermophilic at least above 70-75°F.

In nature the food of this species is restricted to small, smooth-scaled lizards; Alvarez del Toro (1982:153) cites the local Chiapas species of *Scincella* and *Gymnophthalmus* as the common prey. In captivity the present specimen refused over a period of two months all offerings, including crickets, mealworms, small *Sceloporus undulatus garmani* and *Cnemidophorus sexlineatus viridis*, and neonate mice. It was finally force-fed (cooperatively accepted) one *Lumbricus terrestris*, but died some 18 hours later.

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A NEW SUBSPECIES OF *Sceloporus torquatus*
FROM THE SIERRA MADRE ORIENTAL, MEXICO

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Abstract

Sceloporus torquatus inhabiting the northernmost ranges of the Sierra Madre Oriental front range, is described as a new subspecies. Intergradation with southerly, but not westerly populations of the species is discussed. Its relationship to other members of the species is treated. Key words: *Sceloporus torquatus* new subspecies; Tamaulipas, Mexico; geographic range.

High in the grand Tamaulipan pine-oak forest along the eastern front wall of the Sierra Madre Oriental, Mexico occur populations of the lizard species *Sceloporus torquatus* which differ from other populations examined in a species-wide study presently being completed. The purpose of the present paper is to report upon that population, which appears to represent a new subspecies here named

Sceloporus torquatus madrensis subsp. nov.

Description: *Sceloporus torquatus* is a species of lizard large for the genus. Members of this species are brown, olive, or dark slate-gray dorsally, with a bold nuchal collar. *Sceloporus torquatus madrensis* is thought to have derived from the lineage which occurs along the outer slopes of the Sierra Madre (Olson, 1978). Examples of this lineage are usually dark slate-gray or bluish dorsally with a deep gray to black head and nuchal collar (Figure 1). The collar is deep-set, imparting a cape-like effect with complete, white borders. Mature males are entirely dark cobalt-blue on the throat and abdomen; only the rear limbs and tail are dirty white.

These are members of the large-scaled assemblage of the *torquatus* group, all of which have nuchal collars. Dorsals average about 28, ventrals 40 (details of scutellation are given under the variation section below). They are small lizards, compared with other members of the species, attaining an average adult size of little more than 90 mm SVL. The rear limbs are rather long compared with the body length.

Diagnosis: *Sceloporus torquatus madrensis* differs from the noninotypical race (which is part of the same lineage) by having relatively long forelimbs, which, when stretched posteriorly along the body, reach to or near the anterior insertion of the hindlimb (compared to being 6-10 scales distant); a narrow head (length/breadth 1.0 HL/HB - compared to approximately 0.9); and short body length in adults (ca. 90 mm SVL, never reaching 100, compared to ca. 95 mm SVL, often exceeding 100). In almost all other features, there is much resemblance between *S. t. madrensis* and *S. t. torquatus*.



Figure 1. Anterior dorsal aspect of holotype of *Sceloporus torquatus madrensis* from above Rancho del Cielo, Tamps., Mexico, showing dark coloration of head, and nuchal collar.

From the subspecies *S. t. melanogaster*, *binocularis*, and *mikeprestoni*, all plateau races, the subspecies further differs in features additional to the above suite of characters. *Sceloporus torquatus madrensis* has dark dorsal coloration, black head in adults (rather than brown or olive), deep cobalt-blue belly patches which, in adult males, meet at the midline (compared to lighter blue, discontinuous patches), relatively long hind limbs, and broad, complete nuchal collar (similar in both *madrensis* and *mikeprestoni*).

Holotype: Texas A & M University, TCWC 62433, 1740 m, above Rancho del Cielo, 7 km. NW Gomez Farias, Tamaulipas, Mexico, 18 June 1982, by R. E. Olson. An adult male, SVL 84 mm (tail incomplete); femoral length 25 mm, body length 48 mm (FL/BL 0.52); head length 19 mm, head breadth 19 mm (HL/HB 1.0); dorsals 29, ventrals 40, femoral pores 16-16, prefrontals 2, frontonasals 3, preoculars 1-1, loreals 2-1, postoculars 4-5, internasals 7, labiomentals contact mental, frontal divided into anterior and posterior portions, frontoparietals 2-2. Rostral scale with a somewhat convex dorsal edge.

Dorsally the color is dark gray to black with a broad nuchal collar, which anteriorly and posteriorly is edged by chalk-white borders. The center of the dorsum bears dark rhomboid blotches. The nuchal collar is 4-5 scales broad, the borders one scale wide. The posterior border is complete to the

central scale, the anterior broken medially, with the outer ends bent anteriorly. Ventrally the entire surface is dark blue or black posteriorly to the dark-spotted undersurfaces of the posterior limbs, feet, and tail. The throat and outer portions of the belly patches are deep cobalt-blue. A continuous black band extends along the center of the abdomen from the throat posteriorly to the femora. The color of specimens in preservative have become somewhat darker, so that the holotype has the nuchal collar and belly patches almost black.

Paratopotypes: University of Michigan Museum of Zoology, UMMZ 101395, 101400-401, 110743 (field No. 2546 in lot); REO 1184-1186, 1193, 5569.

Variation: Adult SVL, $\bar{X}=90.7$ (82-97) N=9; HL/HB, $\bar{X}=0.97$ (0.92-1.02) N=12; FL/TL, $\bar{X}=0.52$ (.47-.56) N=11; forelimb length (numerical value refers to number of scales between tip of extended limb toe and insertion of femur), $\bar{X}=2.1$ (0-5) N=11; dorsals $\bar{X}=28.5$ (27-29) N=14; ventrals, $\bar{X}=40.2$ (37-43) N=13; femoral pores per side, $\bar{X}=14.8$ (13-17) N=13.

Geographic Range: *Sceloporus torquatus madrensis* most closely resembles *S. t. torquatus*, from which it is apparently directly derived. When compared with other populations throughout the range, the area of intergradation between *madrensis* and *torquatus* appears to be somewhere between the Rancho del Cielo, Tamaulipas locality and the outer slopes of the Sierra Madre Oriental north of Río Moctezuma. But no specimens are available from intervening localities. This situation will be remedied in further collections.

The claim of Smith and Alvarez (1974) that *Sceloporus torquatus mikeprestoni* occurs along the outermost slopes of the Sierra Madre Oriental is in error. The locality at Marcela, Tamaulipas, from which the type series of that race was taken, is 40 km west of the eastern wall of the Sierra Madre, separated from the latter by three xeric hills and semi-desert terrain. Unfortunately those investigators overlooked the well known populations at Rancho del Cielo in their biogeographic discussion. It is clear that *S. t. madrensis* and *S. t. mikeprestoni* have been derived from different lines of descent, even though the two assemblages are separated by such a small distance (see Olson, 1978). This conclusion is reached not only because of the presence of lighter, brown ground color and paler, medially separated belly patches, but also because of the short femora, larger adult body length, and breadth of the head in *mikeprestoni*. In these characters, members of the two assemblages differ more phenotypically than do animals from Rancho del Cielo from those of Morelos or southern Michoacán, which are southerly representatives from which *S. t. madrensis* is thought to have derived. Even greater differences obtain between *S. t. madrensis* and *S. t. binocularis*, a race near and adjacent to *mikeprestoni* geographically.

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ADJUSTMENT OF BROWN TREE SNAKES
(*Boiga irregularis*)
TO A REVERSED LIGHT CYCLE

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Abstract

Seven specimens of *Boiga irregularis* were shifted from a 12L-12D photoperiod with light onset at 07:00 to a 12L-12D photoperiod with light onset at 00:00. The snakes exhibited a nocturnal pattern of activity before the shift and did so afterwards. Adjustment to the new regimen was completed within one week.

Chiszar et al. (1985) found that captive brown tree snakes (*Boiga irregularis*) exhibited a nocturnal pattern of activity, comparable to that seen in the natural habitat (Northern Australia, Solomon Islands, New Guinea; Cogger, 1975; Smith, 1943; Taylor, 1922; Worrell, 1963). Because we intended to observe predatory behavior in these animals (cf., Fritts et al., under review; Jenkins, 1983; Savidge, 1985; Sheppard, 1985), it was decided to shift the laboratory light-dark cycle so that at least part of the animals' active period would overlap with normal human working hours. Accordingly, the 12L-12D photoperiod was shifted from light onset at 07:00 to light onset at 00:00. Thus, snakes could be observed conveniently during a dark period that began at 12:00. Since no data exist on adjustment of *B. irregularis* to reversed photoperiods, the activity of our snakes was monitored from the beginning of this shift in July, 1985, through November, 1985.

Method

Chiszar et al. (1985) used a check-sheet method in which the individually-caged *B. irregularis* (n = 8) were observed several times per day, and scored according to three different binary measures of activity. That study was conducted during June, 1985, with a 12L-12D photoperiod and with photophase (P) starting at 07:00. A similar procedure was followed from July (beginning of P = 00:00-12:00) through November, 1985, except that only one binary measure of activity was taken. A snake was judged to be active if it was out of its hiding box, at least partly uncoiled, and with its head raised off the substrate. Otherwise the snake was judged to be inactive. Inter-observer agreement for this measure was 97%. Temperature was controlled at $26 \pm 1^\circ\text{C}$ by an electric heater, and relative humidity was kept at 50-60% by a humidifier.

A total of 314 observations were made on each of seven snakes. Data were gathered on a quasi-random schedule with two restrictions: (1) half of the observations for each snake were made during P and half were made during scotophase (S), and (2) at least 30 min. elapsed between observations. These were the same animals observed by Chiszar et al. (1985), except for one snake

that died in September, 1985. Data from that snake (taken in July and August, 1985) are not included in this report, although these data did not differ from data taken on the other seven individuals.

During this study snakes were fed neonatal rats once per week. The live prey were placed on the floor of the home cage, about 20 cm from the snake. Twice during P and twice during S we recorded latency (sec) for the snakes to grasp prey. These observations were made in July, 1985; thereafter feeding always occurred during S.

Results

Table 1 shows the mean percent of P and S observations during which snakes were judged to be active, beginning with the first week after the shift from P = 07:00-19:00 to P = 00:00-12:00.

Table 1: Mean percent of observations during which brown tree snakes ($n = 7$) were judged to be active (SEM), along with outcomes of one-way, repeated measures ANOVAs applied to each column and to the last three entries of each row.

	Week 1	Month 1	Months 2 and 3	Months 4 and 5	(F2/12)
Photophase	7.9 (3.6)	11.9 (4.3)	14.5 (4.2)	17.8 (4.2)	0.62
Scotophase	38.1 (8.7)	37.8 (4.9)	47.4 (5.7)	55.0 (7.1)	3.60
F(1/6)	11.42*	15.36***	60.37***	37.52***	

* $P < .05$

*** $P < .01$

Clearly the snakes responded rapidly to this shift in that the S mean activity score was significantly higher than the P score during Week 1. In addition to the statistical tests reported in Table 1, we also executed a 3×2 repeated measures ANOVA treating months (1, 2-3, and 4-5) and P vs. S as orthogonal factors. The P vs. S effect was robust ($F = 95.19$, $df = 1/6$, $p < .01$), but the effect of months and the months $\times$ P vs. S interaction were not reliable ($P_s > .05$). Furthermore, post hoc tests (Newman-Keuls, family-wise error rate set at 0.05) compared the Week 1 means with the means from Months 4-5, and neither the P nor the S comparison attained significance. Hence, the numerical trend toward greater activity scores over successive months seen in Table 1 was not substantiated by any of our statistical analyses.

Mean latency to grasp prey during S was 30.3 sec (SEM = 15.8) whereas the mean during P was 96.8 sec (SEM = 31.3; $t = 2.69$, $df = 6$, $p < .05$).

Discussion

Two statistics from Chiszar et al. (1985) are of interest here: (1) The percent of all P observations, averaged over snakes, during which animals were judged to be active, and (2) the comparable figure for S observations. These means were 15.2 and 45.7, respectively. All of the P vs. S differences reported in Table 1 are of a similar magnitude, indicating that the present L-D cycle elicited an activity pattern comparable to the L-D cycle used in the earlier study. Moreover, adjustment to the reversed photoperiod was virtually immediate (see Table 1, column 1), and it remained stable for five months. Consequently, we believe that observations of nocturnal behavior from 12:00 to 24:00 are probably representative of nocturnal behaviors during other scotophases, including natural ones.

Chiszar et al. (1985) suspended prey 2 cm from the lips of each snake during P and S, with the result that prey were attacked with equal speed in both conditions. In the present study snakes had to move a greater distance to encounter prey, and quicker predation was observed during S than during P. Although this difference agrees with the nocturnal pattern of activity exhibited by the snakes, it is nonetheless interesting that the animals remained vigilant during P and were generally willing to come out of their hiding boxes to attack prey. This behavior suggests that *B. irregularis*, though nocturnal, is capable of capitalizing upon prey that are opportunistically available during P. Whether or not this behavior occurs outside of laboratory cages remains to be established.

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INTRASPECIFIC KLEPTOPARASITISM AND AGGRESSION
IN THE MIDLAND PAINTED TURTLE
(*Chrysemys picta marginata*)

Abstract

Observations of intraspecific kleptoparasitism and aggression over food are reported in captive midland painted turtles (*Chrysemys picta marginata*) for the first time, and compared with similar observations in other species of aquatic turtles. To what extent (if any) these behaviors occur in wild populations of aquatic turtles remains unknown.

In a review of kleptoparasitism in birds, Brockmann and Barnard (1979) defined kleptoparasitism as the interspecific and intraspecific stealing of already procured food. Among reptiles, kleptoparasitism has been reported in several genera of snakes (Burghardt and Denny, 1983), lizards (Greenberg, 1976) and turtles (Boice, 1970; Mahmoud and Klicka, 1979; Hayes, MS). The turtles involved included eastern box turtles (*Terrapene c. carolina*), red-eared sliders (*Pseudemys scripta elegans*), and various kinosternid and emydid turtles. In this note I report observations of intraspecific kleptoparasitism and aggression in midland painted turtles (*Chrysemys picta marginata*), and compare my observations with similar observations in other species of aquatic turtles.

On 30 June 1986, I captured two medium-sized (ca. 13 and 18 cm, respectively) *C. p. marginata* in a marsh near Cheboygan, Cheboygan County, Michigan. I subsequently maintained the turtles during a ca. 15:9 light:dark photoregime in a 38 liter aquarium with water 9-12 cm deep and a ca. 8 x 12 x 24 cm floating log for basking.

On 15 July I fed the turtles approximately 12 small (2.5-4.5 cm) fish (probably *Notropis* spp.), most of which were eaten by the smaller turtle. I fed the turtles again on 23 July, this time placing 4 small *Notropis* and a large (ca. 9 cm) unidentified fish in the aquarium. The small fish were easily consumed. However, the large fish was initially grabbed by the larger turtle, and the smaller turtle responded by pursuing the larger turtle. During the next 15 min. the two turtles fought continuously over the big fish, each stealing it from the other about 5 times; neither turtle appeared to have an advantage over the other. Each time one of the turtles possessed the fish it swam to a corner of the aquarium and continually clawed at the glass floor and sides of the aquarium in an apparent attempt to elude the pursuer. Both turtles bit each other on the claw or head on several occasions; some of the bites appeared intentional rather than accidental. Several days later I released the turtles; no other acts of aggression were observed while the turtles were in my possession.

In previous studies on the ecology of painted turtles, Cagle (1942) and Ernst (1971) did not observe any fighting, aggressiveness, or display of territoriality in *C. p. marginata* and *C. p. picta*, respectively, even when

they were overcrowded. Jackson (1969) and Bury and Wolfheim (1973) reviewed aggression in aquatic turtles, but did not cite any accounts of aggression in *C. picta*. My observations indicate that, in captivity, hungry *C. p. marginata* do not hesitate to fight with each other over food, especially if the food item is large and cannot be swallowed in one piece.

My observations of kleptoparasitism are similar to those of Boice (1970) and Mahmoud and Klicka (1979) in that the turtles involved bit and chased each other in order to obtain food, and those which possessed the food fled in an attempt to elude their pursuers. In contrast, young, captive red-eared sliders (*Pseudemys scripta elegans*) seldom fought with each other over food even when kleptoparasitism occurred (Hayes, MS). A more extensive study comparing kleptoparasitism and aggression in several species of turtles could demonstrate differences in aggression levels between different species.

Previous studies of aggression in aquatic turtles were interpreted as territoriality and the establishment of social hierarchies (e.g., Lardie, 1965, 1983; Rundquist, 1985), as competition for basking sites (e.g., Bury and Wolfheim, 1973), and as a function of courtship (see review by Jackson and Davis, 1972). My observations and those of Mahmoud and Klicka (1979) indicate that aggression also occurs when certain species compete for food. However, the extent (if any) at which kleptoparasitism and aggression over food occurs in wild populations of aquatic turtles is unknown.

Acknowledgment

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ABERRANT COLORATION OF A
Plethodon cinereus cinereus
FROM NEW JERSEY

An individual with the typical dorsal pattern of the red-backed phase of *Plethodon cinereus cinereus* but with white running the length of the straight-edged dorsal stripe instead of the normal red pigment, was collected by the author on 14 October 1976 in a pasture adjacent to a wooded area of Sandyston Township, Sussex County, New Jersey.

Although Conant (1975) notes that the "red" dorsal stripe of this species is sometimes orange and in some specimens may be yellow or even light gray, and Bishop (1943) states that the stripe may even vary through shades of pink, brick-red to bright red, no mention of white is made. Harris (1968 and 1970) records complete and partial albinism for this species in Maryland but does not describe the aeythristic condition found in this New Jersey specimen, which in all other areas of the body, including the eyes, was normally pigmented.

The specimen was photographed alive then preserved in the collection of the New Jersey State Museum (P-305).

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Trimorphodon biscutatus

(REPTILIA: SERPENTES)

ON THE ATLANTIC VERSANT IN SOUTHERN MEXICO

Current knowledge of the distribution of *Trimorphodon biscutatus* (Duméril, Bibron and Duméril) indicates absence of the species from Atlantic slopes in México, except in the upper Río Grande drainage in Chihuahua, where *T. b. wilkinsoni* occurs. Although at one time thought to be restricted otherwise to Pacific slopes throughout its range (e.g., Stuart, 1963:123; Peters and Orejas-Miranda, 1970:310), the species is now known to occur "in some dry Atlantic slope valleys in Guatemala, Honduras and Nicaragua" (Scott and McDiarmid, 1984:1). In no other areas is the species known to occur on Atlantic slopes.

The discovery by one of us (GPH) of the species in the Los Tuxtlas area of southern Veracruz is therefore of great interest. One specimen, an immature female (UNAM-LT 2340 in the herpetological collection of the Estación de Biología Tropical Los Tuxtlas, of the Universidad Nacional Autónoma de México), taken September 7, 1984, is from Totonicanpan, and another was seen but not captured at La Joya, both of which localities are on the periphery of the Laguna de Catemaco. The latter animal was a large adult over one m in length, in an inaccessible recess in a cave where it appeared to be hunting bats. The captured specimen was found in a barren, rocky and sandy area at the northern edge of the lake.

The preserved specimen, 300 mm S-V, tail 60 mm, has 25-27-21 scale rows, 245 ventrals, 90 subcaudals, a divided anal, 2-2 preoculars, 2-2 loreals, 9-9 supralabials, 10-10 infralabials, 3-3 postoculars, 3-3 anterior temporals; 22 dark brown blotches on body, 11 on tail, over a gray background; all blotches H-shaped, fused with small lateral blotches; between each pair of dorsal blotches, two smaller parallel dark lines, longest on anterior part of body; head with a dark band crossing part of prefrontals, anterior part of frontal, one preocular and part of supraocular; a V-shaped mark crossing part of parietals, posterior part of supraoculars and onto frontal; a median dark spot on parietals, extending posteriorly over four nape scales; edges and dorsal parts of labials pigmented; chinshields and venter immaculate; ventrals dark-edged at intervals of 1-2 scales, the dark marks extending over the first three dorsal scale rows,

The specimen at hand appears to be representative of *T. b. biscutatus*, not at all resembling *T. b. quadruplex* of the Guatemala-Costa Rica region, as diagnosed by Gehlbach (1971:209). Wilson and Meyer (1985:110), however, reject the latter as a valid subspecies, referring to it as a microgeographic variant of *T. b. biscutatus*. They also note that in Honduras the species is limited to "Tropical Dry Forest, Tropical Arid Forest, and Subtropical Dry Forest formations," receiving less than 2000 mm of rainfall annually, much as in Guatemala and Nicaragua, whereas the Los Tuxtlas region receives far more rainfall (up to 4000 mm annually). Whether a habitat/ecological difference between *T. b. biscutatus* and *T. b. quadruplex* is maintained throughout their ranges merits examination.

In any event, it seems likely that the Los Tuxtlas population of *T. b. biscutatus* is relictual. It seemingly has not acquired any distinctive characteristics that would set it off taxonomically or produce hyperheteromorphism (Pérez-Higareda and Smith, 1986) as is true of many other populations of the region.

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—Gonzalo Pérez-Higareda, *Estación de Biología Tropical Los Tuxtlas, Apartado Postal 51, Catemaco, Veracruz, México*; and Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado 80309-0334*.

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NEWS AND NOTES:

Copies of CAPTIVE PROPAGATION AND HUSBANDRY OF REPTILES AND AMPHIBIANS are available for purchase. The book, edited by Randall L. Gray, is the proceedings volume from the second conference of the same name, held in 1985 in Davis, California, under the joint sponsorship of the Northern California Herpetological Society and the Bay Area Amphibian and Reptile Society. The book comprises 165 8 1/2 X 11" typescript pages, including illustrations and bibliographies. Orders may be placed with Skip McCampbell, 4321 Victoria Avenue, Union City, CA 94587. Checks for \$18 per copy should be made out to Bay Area Amphibian and Reptile Society.

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- Stearns, Brett C. Captive husbandry and propagation of tortoises.
- Wagner, Ernie. Captive husbandry of wild-caught emerald tree boas.

NEWS AND NOTES:

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All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8½ x 11 inch paper, with adequate margins. Submit original and first carbon, retaining the second carbon. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

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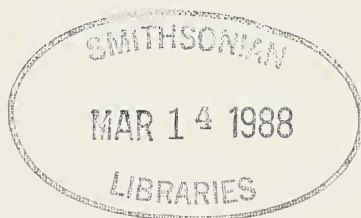
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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

THE IDENTIFICATION OF HABITATS AFTER PATTERNS
OF CO-OCCURRENCE OF AMPHIBIANS AND REPTILES
AT THE SANDY COASTS OF URUGUAY

Eduardo Gudynas

Abstract

The objective of this paper is to evaluate habitat definitions based on a study of two coastal sites in Uruguay. The following environmental subdivisions were recognized: marsh, pond and open formation, transition-pond and transition-marsh. The amphibian and reptile faunas of each subdivision were compared by the Faunal Resemblance Factor and Community Coefficient, and by cluster and ordination analysis. Previous concepts of habitats are discussed and definition presented. Results permit assignment of the transition subdivisions respectively to marsh and pond. Marsh (and its transition), ponds (and its transition) and open formation, each possess distinctive physical features, a plant community and a herpetological assemblage that regularly lives/or breeds in it. All these characteristics conform with the definition of habitat, so this term is applied to them. A brief comment on the coastal sandy biotope is presented.

Introduction

There is an urgent need of basic inventory studies of vertebrate communities of southern temperate areas of South America. This kind of study will lead not only to ecologically noteworthy information but also to data essential for conservation measures. In such studies usually the environment is subdivided into habitats, and species are assigned to them. Elton & Miller (1954:479) stated that the first endeavor in an ecological study is the search for "that elusive thing 'a uniform habitat', hoping to contrast it with other neighbouring 'uniform habitats'". The identification of habitats is difficult, and many times has been considered subjective and biased depending on the field of activity of the researcher. Delimitation rests on the describable identification of an environmental subdivision occupied by a given species, but that process may culminate with only one species occurring in only one, each distinctive habitat (Elton & Miller, 1954). Nevertheless, each species interacts with others, thus requiring conceptual accommodation also of the species assemblage (Elton & Miller, 1954).

Recent herpetological studies in tropical South America (e.g., Dixon & Soini, 1975; Duellman, 1978; Crump, 1971) defined habitats *a. priori*, usually in accordance with vegetation community structure, with which species occurrence was correlated. In temperate South America, Gudynas (1980, 1986) and Gudynas & Rudolf (1986) have recognized a set of habitats of two sites in the Rio de la Plata coasts. The objective of this paper is to re-evaluate their definitions through (i) delimitation of the environmental subdivisions in these same two sites, (ii) identification of assemblages of co-occurrent

species within those subdivisions, and (iii) definition of habitats in accordance with patterns of co-occurrence.

Material and Methods

Species of amphibians and reptiles were studied at Pajas Blancas, Departamento de Montevideo; and Lomas and Medanos de Solymar, Departamento de Canelones, Uruguay. These are coastal sites dominated by sandy dunes, with enclaves of small of medium sized freshwater marshes, and heavily disturbed areas with artificial woodlands (exotic plantation of *Pinus* spp or *Eucalyptus* spp) and human residences. Pajas Blancas also presents rocky points entering the Rio de la Plata waters; associated with them are small ponds.

These two sites were described in detail by Gudynas (1980, 1986) for Solymar; and Gudynas & Rudolf (1986) and Gudynas & Williams (1986) for Pajas Blancas. A list of recorded species, an evaluation of sampling success, and a preliminary analysis of community structure were provided by Gudynas (1986) and Gudynas & Rudolf (1986). At Pajas Blancas 18 amphibian (1 gymnophionan, 17 anurans) and 9 reptilian species (1 turtle, 3 lacertilians, 5 snakes) were recorded between 1977 and 1984, after 25 field trips that represented 342 man-hours of work. At Solymar 14 amphibian (all anurans) and 15 reptilian species (1 turtle, 5 lacertilians and 9 snakes) were recorded between 1977 and 1984, after 46 field trips, in 28 of which I participated, representing 207 man-hours of work.

The occurrence of species among all recognized subdivisions was compared using the Fauna Resemblance Factor ($FRF = 2C/N_i + N_j$) and the Community Coefficient ($CC = C/(N_i + N_j - C)$), where N_i and N_j are the species numbers for environmental subdivisions i and j respectively, and C the number of shared species.

These coefficients evaluates shared species between environmental subdivisions. Phenograms were constructed from the resulting values by the weighted pair group method using arithmetic averages (WPGMA) and polar ordination. Methods and formulae follow Poole (1974). Comparisons were made for the entire herpetological set, and for amphibians and reptiles separately (FRF and CC values identified by the subscripts a and r respectively).

Results

After Gudynas' (1980) study at Solymar, the following environmental subdivisions (excluding those heavily disturbed by human presence), were recognized for both sites: open formations (OF), transition-marsh (T-M), marsh (M), transition-pond (T-P), and pond (P). Species occurrences for OF and M for both localities were grouped, except for P, which was compared only with species of Pajas Blancas. This is not a habitat subdivision, and the transitional areas of difficult assignment are separately analyzed. In the OF subdivision, seven and eight reptiles were recorded at Pajas Blancas and Solymar respectively. However, through observations at other coastal sites

we have added to this subdivision three other species, occurring in adjacent disturbed subdivisions (the scincid lizard *Mabuya dorsivittata*, the amphisbaenian *Anops kingii*, and the colubrid snake *Clelia mustica*).

Ringuet (1962) described and discussed lentic environments, particularly those of Argentina, that are very similar to those in Uruguay. Vegetation for these sites have been studied in detail by Legrand (1960) and Eskuche (1973). In accordance with these studies, the present subdivisions could be briefly characterized as follows: Open formations (Fig. 1), areas of sandy dunes, with scarce vegetation coverage, dominated by psammophytic to psammohalophytic grasses, herbs and shrubs; marshes (Fig. 2), fresh water lentic microlimnotopes, with dense hydrophytic vegetation; ponds (Fig. 3), fresh to salty water microlimnotopes, at rocky outcrops that enters Rio de la Plata, and scarce vegetation on its borders; transition-marsh subdivision, impoverished dense hydrophytic marsh vegetation; and transition-pond subdivision, ponds margins at the OF or rocky outcrop surface.

Species richness (S) or alpha-diversity (Whittaker, 1970) for each environmental subdivision is shown in Fig. 4. The highest S was recorded for M, the lowest for T-P. A clear dominance of amphibians in the microlimnotopes and its transitions was observed, and of reptiles at the open formations.

The pairwise comparisons between all environmental subdivisions resulted as follows. Of the total of 10 pairwise comparisons, the FRF ranged from 0.833 (for T-P x T-M) to 0.181 (OF x P). FRFs higher than 0.500 were obtained in comparisons between pond and marsh subdivisions and their corresponding transitional subdivisions. Faunal similarity between T-M x M (FRF = 0.750) was higher than for TP x P (FRF = 0.518). Fig. 5 presents those results graphically in comparison of the OF, T-M and M subdivisions, where the high similarity between M and T-M is evident. Similar results were obtained by CC coefficient analysis. The results of comparisons between all subdivisions is summarized in Fig. 6, showing that the greatest similarity occurs between transitional subdivisions, and next between these and marsh and ponds.

These analyses were repeated for amphibian and reptiles separately, with results as follows. The pair with the greatest similarity (T-P x T-M) has a high incidence of amphibian shared species (FRF_a = 0.888). A major incidence of amphibians in observed similarities were also detected in TM x M (FRF_a = 0.800) and T-P x P (FRF_a = 0.636). Reptiles also exhibited considerable similarity in comparison of OF x T-P (FRF_r = 0.600), and slightly higher than that due to amphibians in OF x M (FRF_r = 0.266). OF x P presented zero shared species for reptiles.

Polar ordination permits a graphic non-hierarchical representation (Fig. 7) that agrees with the clustering (Fig. 5). Again, transitional subdivisions are more closely related to each other than to their corresponding microlimnotopes.

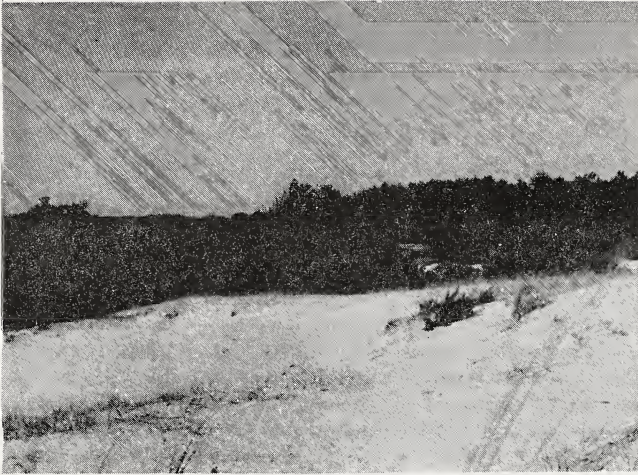


Fig. 1 - Open formation habitat at Solymar site. Sandy dunes with scarce herbs, and *Acacia longifolia* shrubs in the background.



Fig. 2 - Marsh habitat at Solymar site. Marsh hydrophytic dense vegetation is on the right, at the center the transition-marsh subdivision, and on the left the base of a dune.



Fig. 3 - Pond habitat at Pajas Blancas site. Three pond types were distinguished: I, of rock-mud substrate; II, of rock substrate; and III, of mud substrate. Shown is type I substrate, including the transition pond subdivision on the right.

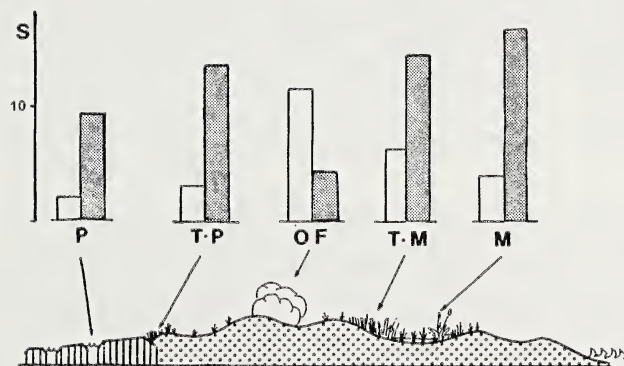


Fig. 4 - Schematic representation of environmental subdivisions at two coastal sites in Uruguay (subdivisions abbreviations as in text). Bars indicate maximum species richness (S) for each subdivision; shaded bars, amphibians; open bars, reptiles.

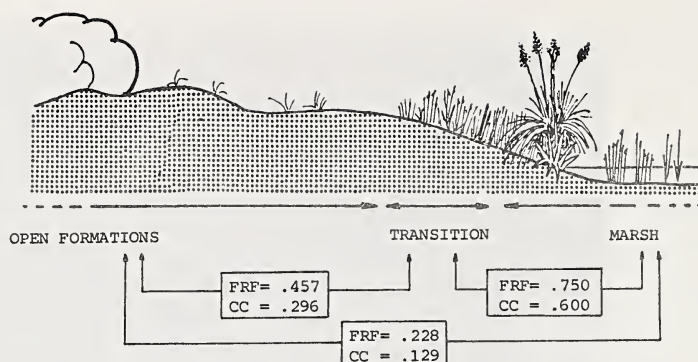


Fig. 5 - Schematic representation of the open formations, transition-marsh and marsh subdivisions, with FRF and CC coefficients comparisons.

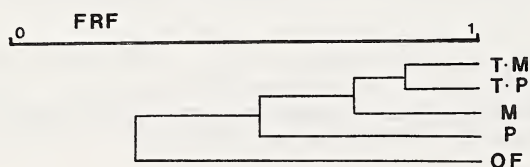


Fig. 6 - Cluster analysis showing relationships of environmental subdivisions according to shared species. The phenogram was obtained from FRF scores, following WPGMA procedure. Cophenetic correlation coefficient, CCC = 0.888. See text for details.

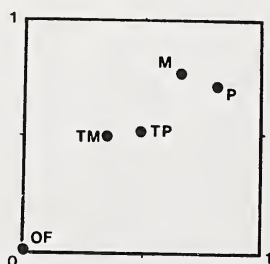


Fig. 7 - Polar ordination of environmental subdivisions. In this analysis, FRF scores were converted to a dissimilarity coefficient, and ordination was derived from the two most different subdivisions. There is an apparent gradient from microlimnotope subdivisions to open formation; see text for further details.

Discussion

Habitat has been defined as the place where a species lives or would seek (Odum, 1972), or the kind of environment where a species occurs and that could be described in physical, chemical, topographic, etc., terms (Whittaker, 1970). Udvardy (1959) presented a more precise definition: it is an abstraction of the essential physical factors and of the essential co-inhabitant biota, in a locality where the species regularly lives and reproduces. Whittaker et al. (1973) restricted the usage of habitat for environmental factors external to the community. However, since the coastal sites studied are inhabited by a unique herpetological community, I follow Kulesza (1975) and use the habitat concept in an intracommunity sense.

Recent usage of the term habitat in herpetological literature reveals the different scope applied to it. As examples, Crump (1971) defined habitat as the physical portion of the environment in which an organism carries out its life processes. Duellman (1978) presented a similar definition. Nevertheless, Duellman (1978) recognized the aquatic and three forest type habitats, which seems more like Crump's (1971) major areas than her habitats. On the contrary, Karr (1980) stated that perception of the animal and not of the human is paramount in recognition of habitats. To evaluate this aspect, I have identified sets of species that co-occur in the same subdivisions. Thus, these species would have similar perceptions and requirements of the environment, as envisioned by Udvardy's (1959) concept. That concept is here broadened to sets of species, following the arguments of Elton & Miller (1954).

At the coastal sites here concerned, analyses show that the transitional subdivisions have a close similarity of shared species with their corresponding microlimnotopes. The lower similarity levels for ponds are probably due to their lower *S*, both for reptiles and amphibians. Similarities between transitional subdivisions and their microlimnotopes are exemplified mainly by shared species of amphibians. Particularly resident anurans, or those that arrive at the breeding season, are responsible for the marsh high *S*. Water levels of the marshes depends mainly on rains (and also on Rio de la Plata water levels for Pajas Blancas ponds), so the transitional subdivisions are actually dynamic.

In the marsh habitat, amphibians are found in the aquatic, aquatic-margin and vertical-low components, whereas in the transition-marsh subdivision they are found in the terrestrial and vertical-low components. The hylid anurans *Hyla p. pulchella*, *H. nana*, *Ololygon eringiophila* and *O. squalirostris* are noteworthy as they are found not only in the aquatic and aquatic-margin components, but also in the stems of some plants (*Cortaderia*, *Eryngium*), where calling males were observed. On the other hand, the ponds are distinct in being occupied by a typhlonectid gymnophionan, *Chthonerpeton indistinctum*, ranging from the fossorial to the aquatic component (Gudynas & Williams, 1986).

Assigning the transitional subdivisions to their corresponding microlimnotopes, the similarities between them are higher than those with open formations. Thus, the term microlimnotope actually shows a structural

and herpetological similarity between ponds (+transition) and marshes (+transition), resulting in a solution to the critical problem in delimiting habitats in these coastal sites, as it was not clear to which habitat the transition should be assigned. The analyses show that most of the species probably perceive, or have, similar requirements for ponds and marshes and their respective transitions.

Considering a gradient of physical factors, it can be also seen that there is a superimposed biotic gradient to which these species also respond, ranging from the terrestrial open formation subdivision to the aquatic marsh and pond. Both clustering and ordination support this statement (Figs. 5,6). In polar ordination, the subdivisions are arranged on a diagonal that suggests a gradient from OF to the microlimnotopes. P and M are more closely related to each other than to their traditional subdivisions, most probably due to an intermediate FRF value (T-M x M, FRF = 0.769; M x P, FRF = 0.600; T-P x P, FRF = 0.518).

Nevertheless, open formation and each microlimnotope, must be retained as different subdivisions. Each has distinctive abiotic characters, and a distinctive vegetal community. Furthermore, each also has its own set of species that regularly live and/or reproduce there. These points constitute the definition of habitat, and they are here designated by that term.

Conclusions

The basic idea of this paper is that the higher-level structure of the herpetological communities is determined by properties of lower levels. If each species has its own perception or requirements of the environment, species with similar requirements or perceptions will tend to co-occur. One or more environmental subdivisions occupied by the same set of co-occurring species is a habitat. The structure of the community can be explained by species assemblages in its habitats. This analysis expands Udvardy's (1959) concept of habitat from one species to a set of species.

Other herpetological studies have applied the habitat concept to only one species. That policy results in only one habitat for each species, the habitat being delimited by species distribution. Nevertheless is commonly recognized that a species' distribution involves more than one habitat. This neglected contradiction in the usage of the habitat concept seems an interesting field for future study.

The present analysis for two coastal sites concludes that transition-pond and transition-marsh subdivisions should be assigned respectively to pond and marsh subdivisions, because they presented a more similar, common fauna, than with the open formation. The similarity is particularly due to shared amphibian species.

On the other hand, open formation, marsh (+transition) and pond (+transition) are different *inter se*, and should be considered as habitats. They present physical, vegetational and herpetological characters that are

distinctive, justifying the habitat definition utilized in this paper, and in Gudynas (1980, 1986) and Gudynas & Rudolf (1986). Marsh and pond habitats are more similar to each other than to the open formation habitat, justifying use of the common term microlimnotope.

These habitats are found in an almost uninterrupted chain of coastal sandy environments of Uruguay and adjacent southern Brasil. I have called this area the sandy coastal biotope, defined by the dominance of quartzitic sand, with fine to medium granulation, temperate weather, and dominated by a characteristic psammophytic to psammohalophytic vegetation, with hydrophytic marsh enclaves (Eskuche, 1973; Gudynas, 1981). The herpetological community of the biotope is indicated in Uruguay, by the presence of the iguanid lizard *Liolaemus wiegmanni*. Soil composition seems to be the determinant factor in the structure and physiognomy of this biotope, so if we consider it in total extension (including southern Brasil) it should be a zonal biome or pedobiome (sensu Walter, 1981). Recognition of biomes approaches a similar recognition of morphoclimatic domins reflecting physiognomy and ecology as described in the herpetological studies of tropical South America by Vanzolini (1970).

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DESCRIPTIVE DENTITION MORPHOLOGY OF LIZARDS OF
MIDDLE AND NORTH AMERICA II: IGUANIDAE

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In a recent article we (Olson, et al., 1986) presented information concerning dentition of several lizard genera, mentioning at that time a forthcoming treatment of the Iguanidae. The present article fulfills that note. The reader is referred to the above-mentioned paper for certain references, illustrations, and literature.

In the present paper, we present descriptive data for iguanid genera. In all, 118 species and 26 genera of 4 families are represented. Of these, 21 genera and 103 species are iguanids. Data and descriptive notes concerning those taxa follow. We employ the taxonomic referents suggested by Smith and Smith (1976).

Family Iguanidae

Genus *Anolis* Daudin

Description. Teeth pleurodont, heterodont. Present on the premaxilla, maxilla, and dentary (pterygoid in some). Haplodont on premaxilla, anterior portion of maxilla and dentary, also on pterygoid, where present. Triconodont on rest of maxilla and dentary. Latter teeth slightly compressed medio-laterally. Typical pleurodont replacement with tendency for alternate succession.

Tooth numbers average 9 (8-11) on premaxilla, 20 (17-24) on maxilla, and 25 (21-28) on dentary (Fig. 1), and 2-4 on pterygoid when present. (For figures refer to earlier article cited above.)

Ratio of medial length of tooth to length of skull averages .05 (.03-.06) on premaxilla, .05 (.02-.07) on haplodont portion of dentary, and .07 (.06-.11) on triconodont portion of dentary. Ratio for width of tooth to length of skull is .01 on premaxilla, .01 to .02 on haplodont portion of dentary, and .02 to .03 on triconodont portion of dentary.

Variants. Pterygoid teeth were found in specimens of *A. carolinensis* and one specimen of *A. sericeus* (UIMNH 3975).

Remarks. Pterygoid teeth are extremely small and undeveloped. Several specimens of *A. carolinensis* showed no evidence of them. No evidence was found of their presence in any species other than the ones cited. However, they possibly exist in other species, but because of their minuteness (those observed were examined under low and high power objective of monocular compound microscope) were not observed. Camp (1923) cited Boulenger (1885), who included "most *Anolis*" in his grouping of lizards

having pterygoid teeth, "some without". Taylor (1940) found no pterygoid or palatine teeth by his examination of *A. nebuloides* and *A. nebulosus*.

Genus *Corytophanes* Boie

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, dentary, and pterygoid bones. Haplodont on premaxilla, anterior end of maxilla, dentary, and pterygoid generally. Teeth smaller on pterygoid. Triconodont on main part of maxilla and dentary. Crowns of triconodont teeth compressed longitudinally. Transition gradual; replacement generally alternate, some variation. New tooth grows into hollowed shaft at base of old tooth (Fig. 2).

Tooth number ranges from 7 (*C. hernandezi*, UIMNH 4000) to 8 on premaxilla (average 8), averaging 19 (15-20) on maxilla, 21 (18-23) on dentary, and 5(4-6) on pterygoid.

Variants. Some slightly triconodont pterygoid teeth were found in one specimen of *C. hernandezi*. Number of teeth in *C. hernandezi* was less than the expected normal for the genus.

Remarks. Only one specimen of *C. hernandezi* was examined. It was considerably smaller than the other specimens of this genus. However, the tooth ratios reveal that the teeth are proportionately larger than the other species. The premaxillary teeth had ratios of length .08, as compared with .06 of *C. percarinatus*, and .05 of *C. cristatus*. The relative width of the dentary teeth is slightly greater and would seem to explain the proportionately less number of teeth present in this specimen. Whether this tooth condition is universal for the species *C. hernandezi* is uncertain.

Genus *Laemanctus* Wiegmann

Description. Teeth pleurodont, heterodont. Haplodont, diconodont, and triconodont crowns. Teeth present on the premaxillary, maxillary, dentary and pterygoid bones. Haplodont on premaxilla, anterior maxilla and dentary and most of pterygoid. Teeth much smaller on pterygoid, some with very slight triconodont crowns. Triconodont type on mid and posterior portion of maxilla and dentary. Transition from haplodont to triconodont gradual, showing one or two transitory teeth as slightly diconodont; small cone on posterior side of crown. Diconodont type more prominent on anterior maxilla. Replacement of teeth typical of pleurodont dentition and apparently alternate.

Tooth number averages 8 (7-10) on premaxilla, 17 (15-20) on maxilla, 22 (20-25) on dentary (Fig. 3) and 3 (2-5) on pterygoid.

Ratio for medial length of tooth to skull length averages .05 (.04-.06) on premaxilla, .05 (.03-.08) for haplodont teeth on dentary, and .08 (.04-.10) for triconodont teeth on dentary. Ratio for width of tooth to

skull length is .01 (.02 for FMNH 36484, *Laemanctus serratus*) on premaxilla, .01 (.01-.02) for haplodont teeth on dentary, and .02 (.01-.03) for triconodont teeth on dentary.

Variants. One specimen (FMNH 49266) of *L. alticoronatus* was found to have some premaxillary teeth that were slightly triconodont.

Remarks. Tooth number and ratio of all species in this genus overlap, making it impossible to distinguish one species from the other on these tooth characters.

Genus *Basiliscus* Laurenti

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, dentary, and pterygoid bones. Most have haplodont type on premaxilla and extreme anterior end of dentary; on the latter, usually the first two or three teeth. One larger specimen had a few triconodont type teeth included on premaxilla together with haplodont type. All of maxilla and major portion of dentary contain well developed triconodont teeth. Transition from haplodont to triconodont gradual, terminating in a fan-shaped crown posteriorly. Teeth on pterygoid smaller than those on other bones; change from haplodont to triconodont posteriorly. Replacement typical of pleurodont dentition. New teeth (with fully shaped crowns) grow into base of old teeth. Alternation of replacement is apparent, every other tooth anteriorly and every second tooth posteriorly. Cheek and posterior teeth compressed medio-laterally.

Tooth number averages 8 (7-8) on premaxilla, 19 (18-20) on maxilla, 22 (20-23) on dentary, and 5 (3-7) on the pterygoid (Fig. 4).

Ratio for length of tooth to length of skull averages .06 (.05-.06) on premaxilla and .08 (.06-.10) on dentary. The width ratio was .01 on premaxilla and from .01-.02 on dentary.

Remarks. Six specimens were examined. All showed constant shape, number and ratio as indicated above. Taylor (1940) examined 3 specimens of *B. vittatus* and found no palatine teeth, but an average of 5 (1-7) on the pterygoid.

Genus *Iguana* Laurenti

Description. Teeth pleurodont, homodont. Present on the premaxillary, maxillary, dentary, and pterygoid bones. All teeth have finely denticulated crowns, which are compressed medio-laterally, with slight beveled surfaces on both medial and lateral aspects of the crown. Cheek and posterior teeth have overlapping crowns. Anterior side of crown overlaps posterior medial side of crown of tooth just anterior to it. Pterygoid teeth very small, simple, in irregular transversely curved rows. Replacement appears alternate. New tooth crown, already with denticulations, grows into hollow base of old one (Fig. 5).

Teeth number 7 on premaxilla, 28 on maxilla, and 30 on dentary. The number of teeth on pterygoid is uncertain because of irregularity of placement and size. They are clumped together in several irregular rows making number of empty tooth depressions impossible to determine.

The ratio of medial length of tooth to length of skull is .06 for premaxillary teeth and from .04 to .09 for dentary teeth. Width ratio is .01 on premaxilla and from .01 to .02 on dentary.

Variants. Specimens show several haplodont teeth together with the denticulated ones on the premaxilla.

Remarks. Two specimens were examined. Cope and Boulenger use the tooth character "Lateral teeth only, with denticulated crowns". We have found, however, that one specimen examined has denticulated crowns on the premaxillary teeth. Taylor (1940) reported "pterygoid teeth in short transversely curved group" in one specimen examined. Five to six teeth were found on the pterygoid, no "palatine teeth".

Genus *Ctenosaura* Wiegmann

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, dentary, and pterygoid bones. Crowns range from haplodont, triconodont, to four cones; one specimen shows five cones. Haplodont on premaxilla, pterygoid, and anterior end of maxilla and dentary. Teeth on pterygoid in one or two rows; very small in comparison to main teeth. Teeth on anterior end of maxilla very large, recurved, with sharp conical crowns directed posteriorly. First three or four teeth on dentary like those on anterior maxilla. Lateral teeth compressed medio-laterally. Transition more or less gradual. Replacement typical of pleurodont dentition, alternate teeth involved (Fig. 6).

Tooth number ranges from 6 (*C. similis*, UIMNH 18635) to 9 (*C. acanthura*, UIMNH 1595) (av. 7), on premaxilla, averaging 24 (19-28) on maxilla, 29 (21-36) on dentary, and 17 (9-30) on pterygoid.

Ratio of medial length of tooth to length of skull averages .07 (.05-.09) on premaxilla, .06 (.03-.11) on haplodont portion of dentary, and .08 (.04-.10) on triconodont, etc., portion of dentary. Ratio for width of tooth to length of skull averages .02 (.02-.03) on premaxilla, .02 (.01-.03) on dentary, and .02 (.01-.03) on the rest of the dentary.

Variants. In *C. pectinata*, all specimens showed evidence of five cones on several of the posterior teeth. Also, the average number of teeth on the maxilla and dentary in this species is significantly higher than that of the other species. The range on the maxilla is from 24 to 28, and on the dentary, from 31 to 36, whereas the range for the other species is from 19 to 26 on the maxilla, and 21 to 34 on the dentary.

Remarks. The reason for the slight difference in number mentioned for *C. pectinata* may be due to the fact that the average width ratio of the teeth on the dentary is slightly smaller in that species, allowing more room for several teeth. Too much stress cannot be placed on this difference, as the range of tooth number is rather large for each species and the number examined may not represent the true norm for each species.

Boulenger (1885) and Bailey (1928) stated that pterygoid teeth are present in this genus. Boulenger described the teeth observed in this genus as "Lateral teeth tricuspid;...". Cope (1900), in his description of teeth in *C. hemilopha*, said "...maxillaries (in one specimen) 21, of which six are conical, the third longest, and very few of the remainder more than tricuspid". This would show the existence of four- and five-coned teeth, although only implied. Taylor (1940) examined two specimens of *C. acanthura*, which had an average of 15 (4-23) pterygoid teeth.

Genus *Enyaliosaurus* Gray

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, dentary, and pterygoid bones. Haplodont on premaxilla, extreme anterior end of dentary, and pterygoid, where teeth are much smaller and less developed. Triconodont on most of maxilla and major portion of dentary. Some teeth near posterior end of dentary and maxilla have four cones, the fourth one being on anterior side. Crowns are compressed medio-laterally. Pterygoid teeth in one row. Typical pleurodont replacement with tendency for alternate succession (Fig. 7).

Tooth number averages 6 (5-7) on premaxilla, 18 (15-22) on maxilla, 22 (19-25) on dentary, and 10 (6-13) on pterygoid.

Ratio of medial length of tooth to length of skull ranges from .03 (UIMNH 52512) to .06 (av. .05) on premaxilla, and averages .05 (.04-.05) on haplodont portion of dentary and .07 (.04-.09) on triconodont portion of dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on premaxilla, .02 (.01-.02) on haplodont portion of dentary, and .02 (.02-.03) on triconodont portion of dentary.

Remarks. The small ratio found might have been because of the measurement of an incomplete tooth. The other specimens of the same species all have ratios of .06.

Genus *Dipsosaurus* Hallowell

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, dentary, and pterygoid bones. Premaxillary teeth triconodont, having small lateral cones with sharp main central cone. Gradual transition posteriorly to four-, five-, six-, and seven-coned teeth. In six-coned teeth, one more cone anterior to main central cone than posterior to it. Pterygoid teeth haplodont, very small, poorly developed, in

single row. All teeth compressed medio-laterally. Anterior part of each crown of lateral teeth slightly overlaps posterior part of preceding tooth. Replacement true pleurodont type, with some indication of alternate nature, although somewhat irregular (Fig. 8).

Tooth number averages 6 (6-7) on premaxilla, 19 (18-20) on maxilla, 22 (21-24) on dentary, and 5 (4-5) on pterygoid.

Ratio of medial length of tooth to length of skull averages .04 (.04-.05) on premaxilla, .06 (.03-.10) on dentary. Ratio for width of tooth to length of skull is .01 on premaxilla, and .02 (.01-.02) on dentary.

Remarks. We disagree with Cope's (1900) description of the teeth in *Dipsosaurus dorsalis*, who claimed that "...all the teeth on the maxillary bone are tricuspidate;...", and Boulenger's (1885) statement that "Lateral teeth (are) tricuspid". As we have shown above, the number of cones of the teeth of the maxilla range from three to seven.

Taylor (1940) found on one specimen 0-4 pterygoid teeth in *D. dorsalis*. Cope (1892) described the premaxillary teeth in this species as "mostly simple, but one or two external ones show a rudimental lateral cusp". All specimens examined in the present study have triconodont teeth only on the premaxilla.

Genus *Sauromalus* Dumeril

Description. Teeth pleurodont, heterodont. Present on the premaxilla, maxilla, dentary, pterygoid, and (?) palatine. Gradual transition posteriorly from haplodont, to triconodont, five and six cones. In five-coned crowns, three cones anterior to main central cone, only one posterior to it. In six-coned crowns, three anterior and two posterior to mid-cone. Some overlapping of crowns occurs in cheek teeth. Overlapping is the same as in *Dipsosaurus*, anterior side of crown slightly overlaps medial side of posterior portion of crown immediately preceding it. Crowns medio-laterally compressed. Haplodont teeth found on premaxilla, extreme end of maxilla, dentary, pterygoid and (?) palatine bones, very small on latter bones. Replacement tending to involve every other tooth, but no definite replacement pattern observed. New teeth grow into degenerating shaft of old ones (already denticulated) (Fig. 9).

Ratio of medial length of tooth to length of skull averages .08 (.07-.09) on premaxilla, and .06 (.04-.09) on dentary. Ratio for width of tooth to length of skull averages .02 (.01-.03) on premaxilla, and is .01 to .04 on the dentary.

Variants. No pterygoid teeth were found in the specimen of *S. ater*, but "sockets" on the medial portion of the bone gives evidence of their presence.

Remarks. There was no indication of the presence of palatine teeth in three specimens examined. Cope mentioned the "distinct" presence of them, which should be regarded with less skepticism since it is far easier to state with certitude the presence of teeth than their absence, in which case one must resort to discovery of presence of sockets. However, Taylor (1940), who examined three specimens of *Sauromalus obesus*, did not mention the presence of palatine teeth. He reported presence of 0-8 (av. 6) pterygoid teeth. Boulenger (1885) said "Lateral teeth tricuspid; no pterygoid teeth(?)".

Genus *Holbrookia* Girard

Description. Teeth pleurodont, subheterodont. Present on the premaxillary, maxillary, and dentary bones. Haplodont on all except on posterior part of maxilla and dentary, where there is slight triconodonty. Transition gradual. Crowns very slightly compressed medio-laterally. Teeth directed perpendicular to longitudinal axis of bone. Typical pleurodont replacement with vague alternate pattern (Figs. 10 & 11).

Tooth number averages 7 (6-7) on premaxilla, 20 (18-22) on maxilla, and 24 (20-27) on dentary.

Ratio of medial length of tooth to length of skull averages .05 (.02-.06) on premaxilla, .06 (.04-.07) for haplodont teeth on dentary, and .07 (.06-.07) for triconodont teeth on dentary. Ratio for width of tooth to length of skull is .01 on premaxilla, .01 for haplodont teeth on dentary, and .02 (.01-.02) for triconodont teeth on dentary.

Variants. Some specimens of *Holbrookia maculata* have 27 dentary teeth; in all other species examined, the range is 20 to 25.

Remarks. There seems to be a slight development of triconodonty between *Holbrookia*, *Cophosaurus*, *Callisaurus*, and *Uma*. Slight triconodonty is noted in *Holbrookia maculata*, somewhat more so in *Holbrookia propinqua*, and most pronounced in *Cophosaurus*, *Callisaurus* and *Uma*.

Genus *Cophosaurus* Troschel

Description. Teeth pleurodont, subheterodont. Present on the premaxilla, maxilla, and dentary. Haplodont on all except on posterior part of maxilla and dentary, where they are somewhat triconodont. Transition is gradual. Crowns slightly compressed medio-laterally. Replacement is typical pleurodont, with vague alternate pattern.

Tooth number ranges from 6 to 7 (av. 7) on premaxilla, 18-22 on maxilla, and 22 to 27 on dentary (Fig. 12).

Ratio of medial length of tooth to length of skull averages .05 (.03-.06) on premaxilla, .06 (.04-.07) for haplodont teeth on dentary, and .07 (.06-.07) for triconodont teeth on dentary. Ratio of width of tooth to

length of skull is .01 on premaxilla, .01 for haplodont teeth on dentary, and .02 (.01-.02) for triconodont teeth on dentary.

Genus *Callisaurus* Blainville

Description. Teeth pleurodont, subheterodont. Present on the premaxillary, maxillary, and dentary bones. Most haplodont except posterior teeth, which are slightly triconodont. Transition gradual. Crowns on triconodont teeth slightly compressed medio-laterally. Teeth directed perpendicular to the longitudinal axis of the bone. Replacement of teeth typical of pleurodont dentition. Alternate succession suggested.

Tooth number ranges from 6 to 9 on premaxilla, and averages 21 (19-23) on maxilla, and 23 (23-24) on dentary (Fig. 13).

Ratio of medial length of tooth to length of skull averages .05 (.04-.06) on premaxilla, .06 (.04-.08) for haplodont type on dentary, and .07 (.06-.08) for triconodont type on dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on premaxilla, .02 (.01-.02) for haplodont type on dentary, and .02 (.01-.02) for triconodont type on dentary.

Variants. Nine teeth were found on the premaxilla of UIMNH 34827, as compared with the usual 6 to 7 in the others.

Remarks. Boulenger (1885) in his description of the genus, said "Lateral teeth indistinctly tricuspid; not pterygoid teeth". Cope (1900) said, "no palatine teeth; cheek teeth conical; posterior only faintly tricuspid".

Genus *Uma* Baird

Description. Teeth pleurodont, subheterodont. Present on the premaxillary, maxillary, and dentary bones. Most haplodont, except cheek and posterior teeth, which are slightly triconodont. Transition from haplodont to triconodont gradual. Crowns on triconodont teeth slightly compressed medio-laterally. Typical pleurodont replacement with tendency for alternate succession.

Tooth number averages 6 (5-7) on premaxilla, 19 (17-21) on maxilla, and 24 (20-26) on dentary (Fig. 14).

Ratio of medial length of tooth to length of skull averages .06 (.04-.07) on premaxilla, .05 (.03-.08) for haplodont type on dentary, and .07 (.04-.09) for triconodont type on dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on premaxilla, .02 (.01-.02) for haplodont type on dentary, and .02 (.01-.02) for triconodont type on dentary.

Remarks. The dentition of *Uma* closely resembles that of *Callisaurus* and *Cophosaurus*, with ranges of variation of number and ratio overlapping

extensively in all three. However, of the three, *Uma* has the distinction of having lateral teeth besides posterior teeth which are slightly triconodont. Cope (1900) said, "Cheek teeth tricuspid". Boulenger found the "Palate without teeth".

There seems to be a slight progression of development of triconodonty between *Holbrookia*, *Callisaurus*, *Cophosaurus* and *Uma*. *Holbrookia maculata* has a very slight suggestion of the triconodont type. This condition is more evident in specimens of *H. propinqua*, and seems to become increasingly pronounced in *Callisaurus*, *Cophosaurus* and *Uma*. A close similarity between *Cophosaurus* and *Callisaurus*, though rather weak, may be used in conjunction with other morphological features in aiding to correlate their structure with their ecological niche.

Genus *Petrosaurus* Boulenger

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, and dentary bones. Haplodont and triconodont crowns present. Haplodont on premaxilla, extreme anterior end of maxilla and dentary. Lateral teeth of maxilla and dentary triconodont. Crowns slightly compressed, recurved. Transition from haplodont to triconodont gradual. Typical pleurodont succession with tendency for every other or every two teeth to be replaced (Fig. 15).

Tooth number 7 on premaxilla, average 21 (19-25) on maxilla, and 25 (22-29) on dentary.

Ratio of medial length of tooth to length of skull averages .06 (.05-.07) on premaxilla, .06 (.05-.07) on haplodont portion of dentary, and .07 (.05-.08) on triconodont portion of dentary. Ratio for width of tooth to length of skull is .01 on premaxilla, .02 (.01-.02) on haplodont portion of dentary.

Variants. Slightly triconodont teeth were found on the posterior portion of the premaxilla in one specimen of *P. thalassinus* (USNM 15591). No haplodont teeth were found on the maxilla or dentary in that specimen.

Remarks. The above mentioned specimen was considerably larger than the others and exhibited many more teeth on the maxilla and dentary. This seems to indicate that the number of teeth increases with age of the individual, but the proportion of the size of the teeth to the size of the body is fairly constant, regardless of age.

Boulenger (1885) mentioned that only the "lateral teeth" are triconodont.

Genus *Streptosaurus* Mittleman

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, and dentary bones. Haplodont and triconodont crowns

present. Haplodont on premaxilla, anterior end of maxilla and dentary. Triconodont on lateral sides of maxilla and dentary. Crowns slightly recurved, compressed medio-laterally. Transition from haplodont to triconodont gradual. Typical pleurodont succession with tendency for alternate replacement.

Tooth number averages 6 (5-6) on premaxilla, 22 (21-22) on maxilla, and 27 (26-28) on dentary (Fig. 16).

Ratio of medial length of tooth to length of skull is .06 on premaxilla, .05 (.04-.07) on haplodont portion of dentary, and .06 (.04-.07) on triconodont portion of dentary. Ratio for width of tooth to length of skull is .01 on premaxilla, .01 on haplodont portion of dentary, and .01 (.01-.02) on triconodont portion of dentary.

Genus *Crotaphytus* Holbrook

Description. Teeth pleurodont, subheterodont. Present on the premaxillary, maxillary, dentary, pterygoid, and palatine bones. Haplodont on premaxilla, pterygoid, palatine and anterior end of maxilla and dentary. Lateral and posterior teeth slightly triconodont with slightly medio-laterally compressed crowns. Anterior teeth on maxilla and dentary slightly recurved. Replacement typical of pleurodont dentition, with every other or every two teeth being replaced, although this is somewhat irregular. Palatine and pterygoid teeth very small, undeveloped, and forming one or two rows.

Tooth number averages 7 (6-7) on premaxilla, 17.5 (15-20) on maxilla, 20 (18-23) on dentary (Figs. 17 & 18), about 10 (9-20) on pterygoid, and about 4 (3-5) on palatine.

Ratio of medial length of tooth to length of skull averages .05 (.04-.05) on premaxilla, .05 (.03-.07) for haplodont type on dentary, and .07 (.04-.08) for triconodont type on dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on premaxilla, .01 (.01-.02) for haplodont type on dentary, and .02 (.01-.02) for triconodont type on dentary.

Variants. Specimens of *C. silus* have a premaxillary ratio of .04 as compared to the other species which have a constant .06 ratio.

Remarks. Whether or not this difference just described in premaxillary tooth ratios is significant depends upon further investigation. Two other species, *C. dickersonae* and *C. insularis*, were not examined for this feature. Boulenger (1885) cited iguanids with pterygoid teeth as only 4 species of *Crotaphytus* (1 species without). Taylor (1940) found 12-15 pterygoid teeth and no palatine teeth in one specimen of *C. reticulatus*. As shown above, 5 palatine teeth were found in specimens of some species. Taylor examined 14 specimens of *C. collaris* and found pterygoid teeth to average 12 (3-24). He found palatine teeth present also, averaging 2 (0-5).

Genus *Phrynosoma* Wiegmann

Description. Teeth pleurodont, homodont, haplodont. Present on the premaxillary, maxillary, and dentary bones. Crowns compressed, slightly recurved. Replacement alternate for the most part, typical pleurodont succession. Lateral teeth have slight suggestion of triconodont type crown.

Tooth number averages 5 (4-8) on premaxilla, 16 (13-19) on maxilla, and 20 (16-24) on dentary (Fig. 19).

Ratio of medial length of tooth to skull length is quite constant within all species. Also true for ratio of width of tooth to length of skull. Ratio for length of tooth averages .04 (.02-.06) on premaxilla and .05 (.02-.08) on dentary. The width ratio averages .01 (.01-.02) on both bones.

Variants. In *Phrynosoma solare* the medial length of tooth to length of skull is .02 (.03 on one tooth), which is a deviation from the normal for this genus having a ratio average of .05.

Remarks. *Phrynosoma solare* deviates from the normal pattern of tooth to skull length found in this genus. In the specimens examined, the largest tooth did not exceed a tooth-skull ratio of .03, which seems to be significant in view of the fact that all the other species examined have a ratio exceeding .03. In these latter specimens, .03 was the ratio for the smallest tooth. One specimen of *P. solare* has a ratio of .02 to .03; the other had a .02 ratio. The only other species of this genus to approach these small ratios is *P. modestum*. Three specimens were examined and all showed a .03 ratio for premaxillary teeth and .03 to .04 ratios for dentary teeth.

Cope (1900) indicated that *P. solare* occupies an isolated position in the genus for several reasons, the principal ones being "The presence of four equally developed occipital horns instead of the two which characterize all the other species, the continuity of the femoral pore series across the middle line, and the tuberculation of the scales..."

There is a possibility that this ratio difference would show significance taxonomically, should the ratios tend to be constant as is the case within the species examined.

Genus *Sceloporus* Wiegmann

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, and dentary bones. Haplodont on premaxilla, and anterior portions of maxilla and dentary. Triconodont on the rest of maxilla and dentary. Gradual transition posteriorly from haplodont to triconodont. Replacement typical pleurodont type. In general, teeth replace alternately anteriorly and every second one posteriorly.

Tooth number averages 6 (5-8) on premaxilla, 21-22 (18-28) on maxilla, and 25 (21-33) on dentary (Fig. 20-23).

Ratio of medial length of tooth to length of skull averages .06 (.04-.08) on premaxilla, .06 (.02-.09) on haplodont portion of dentary, and .07 (.04-.11) on triconodont portion of dentary. Ratio for width of tooth to length of skull averages .01 (.01-.02) on all tooth bearing bones, having an average of .01 on premaxilla, and .01 on haplodont portion of dentary, and .02 on triconodont portion of dentary.

Variants. Posterior teeth on maxilla protrude more noticeably in *Sceloporus clarki* than in the other species. The anterior maxillary teeth (3,4,5) also protrude noticeably, but this condition is characteristic of the whole genus, though varying in degree.

Sceloporus serrifer (taxonomic ref., Olson, in press) varies from the others by often having the main midcone of the triconodont teeth greatly flattened (Fig. 20), giving the appearance of one broad cone with slight lateral lobes.

Sceloporus spinosus varies from the other species in having the largest ratio for the medial length of the tooth to length of the skull on the premaxilla (.08) and on the triconodont portion of the dentary (.11).

Remarks. Structurally, the teeth of all species observed in this genus are identical, with the sole exceptions noted above. In the case of *Sceloporus spinosus*, the .08 ratio was common to all, the .11 in one specimen. It has been obvious during the course of this study that the number and ratios vary within each group, and that the ranges of variation overlap considerably. Because of this fact, the morphology of the teeth cannot be used in support of higher categories such as species groups.

Genus *Sator* Dickerson

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary and dentary bones. Haplodont and triconodont crowns present. Haplodont on premaxilla, anterior portion of maxilla and dentary. Triconodont on lateral portion of maxilla and dentary. Crowns slightly curved and compressed medio-laterally. Transition from haplodont to triconodont gradual. Typical pleurodont succession with possibility for alternate replacement.

Tooth number averages 6 on premaxilla, 21 (19-23) on maxilla, and 26 (23-28) on dentary (Fig. 24).

Ratio of medial length of tooth to length of skull averages .06 (.05-.06) on premaxilla, .05 (.03-.06) on haplodont portion of dentary, and .06 (.05-.07) on triconodont portion of dentary. Ratio for width of tooth to length of skull averages .02 (.01-.02) on premaxilla, .01 (.01-.02) on haplodont portion of dentary, and .02 (.01-.02) on triconodont portion of dentary.

Remarks. One specimen was considerably smaller than the others in the species, and exhibited fewer teeth than the others on the maxilla and on the dentary. This appears to indicate that the younger animals have fewer teeth, increasing in number with the age of the individual, but that the ratio of tooth size to skull size remains fairly constant.

Genus *Urosaurus* Hallowell

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, and dentary bones. Haplodont on premaxilla, anterior part of maxilla and dentary. Triconodont on remainder of maxilla and dentary. Gradual transition posteriorly from haplodont to triconodont. Succession typical of pleurodont dentition and alternate replacement generally. Slight medio-lateral compression.

Tooth number averages 6 (5-7) on premaxilla, 20 (19-22) on maxilla, and 23-24 (21-26) on dentary.

Ratio of medial length of tooth to length of skull averages .05 (.05-.06) on premaxilla, .06 (.03-.08) on haplodont portion of dentary, and .07 (.06-.10) on triconodont portion of dentary. Ratio for width of tooth to length of skull is .01 for premaxilla, .01 (.01-.02) on haplodont portion of dentary, and .02 (.01-.02) for triconodont portion of dentary.

Variants. A specimen of *Urosaurus bicarinatus* (UIMNH 11128) had a few triconodont teeth on the dentary that reached a ratio of .10, which is rather high within this genus. However, only one specimen of three of this species showed such a ratio.

Remarks. The teeth are the same as those found in *Uta*. With the one exception given above, all the species of this genus are fairly constant in terms of shape, size and number of teeth. Considerable overlap is observed in ranges of variation of number and ratio of the teeth.

Genus *Uta* Baird and Girard

Description. Teeth pleurodont, heterodont. Present on the premaxillary, maxillary, and dentary bones. Haplodont on premaxilla, anterior portion of maxilla and dentary. The rest of maxillary and dentary teeth are triconodont. Transition gradual posteriorly from haplodont to triconodont. Crowns slightly compressed medio-laterally in triconodont type. Replacement typically pleurodont type and alternate or involving every other two teeth.

Tooth number is 6 on premaxilla, averages 20 (18-23) on maxilla, and 25 (23-29) on dentary.

Ratio of medial length of tooth to length of skull averages .05 (.03-.06) on premaxilla, .04 (.02-.06) on the haplodont portion of the dentary, and .06 (.04-.07) on triconodont portion of the dentary (Fig. 25).

Remarks. Tooth number, and ratios of all species in the genus overlap, making it impossible to distinguish one species from the other on these tooth characters.

Discussion and Conclusions

An attempt has been made here to discover if any one or more characters of teeth could be utilized advantageously in distinguishing lizards at a species or higher taxonomic level. An extensive account of the measurement and numerical results has been presented along with range of variation of tooth ratios and tooth numbers. Further, we estimated the nature of variability present within the species and within the genus.

A general rule can be applied, that is that the teeth in any one lizard are unequal in size, regardless of whether dentition is homodont or heterodont. Obviously, therefore, the range of variation of relative tooth size in any individual may include the ranges of other individuals within the same species. The overlapping ranges of size render it impossible to separate most species on this character alone, nor would it be very practical, with two or three exceptions, to use such ranges of variation together with other characters for specific differentiation.

The possible exceptions to the apparent insignificance of relative tooth size as a distinguishing feature between species are *Phrynosoma solare*, *Sceloporus clarki*, and *Sceloporus spinosus*.

The ratios reveal that the size of the tooth at any part of the jaw is directly proportional to the length of the skull. This statement perhaps can be broadened to include the corresponding size of the lizard body (Cawston, 1947). Also relevant from the ratios is that the range of relative size of teeth is fairly constant throughout the species and genus. There is an indication of constancy in relative size of teeth between the families Scincidae, Teiidae, Helodermatidae and Iguanidae.

The problem of tooth number presents a condition similar to that of ratios and tooth size. Not only do the teeth vary in number between the species, but also within the species. In fact, the number may vary from one side of the jaw to the other in the individual. Such a character alone could not be of value to distinguish between species, nor could the combined application of tooth size and tooth number aid in specific classification.

Owen (1840-45) stated "It is rare that the number of teeth is fixed and determinate in any reptile so as to be characteristic of the species". This statement certainly applies to Sauria. The ranges of tooth number overlap extensively. The number of teeth tends to remain constant for the genus and species within a given range. And, tendency is evident for there to be a lesser number of teeth in younger specimens of species.

The premaxilla appears to be the tooth-bearing bone most constant in terms of numbers of teeth. Of all the species examined, the total range of

tooth numbers, from the smallest to the largest extreme, never involved an interval of more than three teeth. The difference between extremes of count of the maxillary teeth never exceeded seven. The dentary exhibited a large amount of variation; in one specimen of *Ctenosaura*, the interval of tooth number varied as much as thirteen. In those species having pterygoid teeth, twenty-one was the limit of difference between tooth-number-range extremities (most in *Ctenosaura*). Palatine teeth, when present, were found to differ numerically by one.

At the generic level, the total range of relative tooth size and number, together with more distinguishing characters, i.e., shape and location, could be utilized very adequately in the description and differentiation of most genera.

In summary, the observations reveal the following. In the Iguanidae, homodont dentition is rare, exhibit only in *Iguana* and *Phrynosoma*. *Holbrookia*, *Callisaurus*, and *Uma* might be considered homodont or "subheterodont", as only a slight trace of triconodonty is present in the posterior teeth. Heterodont dentition prevails in the rest of the genera to varying degrees. The most general type of heterodont dentition consists of only haplodont and triconodont crowns. *Basiliscus* has the triconodont type throughout the maxillary and dentary bones and is haplodont only on the premaxilla. *Crotaphytus* and *Laemanctus* have the distinction of being the only genera of Iguanids in North America that possess several diconodont teeth on the maxilla and dentary. Pterygoid teeth are present in some *Anolis* (*A. carolinensis* and *A. sericeus*), *Cryptophanes*, *Laemanctus*, *Basiliscus*, *Iguana*, *Enyaliosaurus*, *Ctenosaura*, *Dipsosaurus*, *Sauromalus*, and *Crotaphytus*. Palatine teeth have been reported to exist in *Sauromalus* by Cope (1900), but no evidence of such teeth was found in the present study.

The teeth of North American genera of the family Teiidae may be characterized as ranging from haplodont to triconodont, slightly compressed. They are pleurodont or modified pleurodont (some *Cnemidophorus*) with long or short, cylindrical shafts and hollow bases. The bases may be slightly larger than the main part of the shaft (some *Cnemidophorus*). There is a tendency for every other one or every other two teeth to be replaced.

Homodont dentition exists only in *Gymnophthalmus*, all the teeth being of the haplodont type. *Ameiva* and *Cnemidophorus* display heterodont dentition. Pterygoid teeth are universally present in *Cnemidophorus* but absent in *Gymnophthalmus* and most *Ameiva* (only one specimen of *Ameiva festiva* exhibited pterygoid teeth).

It was believed until 1922 that reptilian teeth were replaced irregularly. Bolk has attempted to show by histological and embryological evidence, that the replacement of teeth in pleurodont lizards is regular and alternate. He demonstrated that the tooth germs develop in two distinct rows, one on the side of the dental lamina. Although the replacement did not appear to be entirely regular, Bogert (1943) found many of the Iguanidae to have "...a pattern involving successive shedding of every fourth or fifth tooth..." We have observed a tendency for alternate replacement in most of the specimens examined.

Our observations of *Heloderma* confirm the findings of Bogert (1943). A definite alternate replacement was evident with the alternate teeth being firmly ankylosed. This condition, as Bogert stated, is a "...pattern similar to that in snakes..."

Specimens Examined

Of the specimens examined, many still must bear Taylor's (EHT) catalogue numbers, from during early portions of this study. Extensive search through major collections, and generous work of curators and assistants in various institutions has failed to reveal the present whereabouts of all specimens. Moreover, an earlier fire at the University of Kansas (Duellman, pers. comm.) may well have destroyed some of them or caused some confusing situation to exist. This regrettable situation may be partly or wholly resolved as specimens are discovered; or it may never be resolved. It is possible that some reside among 35,000 Taylor specimens at the Field Museum of Natural History; but those have not been catalogued (H. Marx, pers. comm.).

Iguanidae

ANOLIS: *Anolis limifrons rodriguezi* Bocourt: EHT 15248 (UIMNH 20025), Balchacaj, Campeche, Mex.; EHT 15254 (UIMNH 22017), Tres Brazos, Campeche, Mex.; *Anolis carolinensis* Voigt: UIMNH 880, 881, 885, 13 mi. NW Saratoga, Hardin Co., Tex.; *Anolis dunnii* Smith: EHT 11095 (UIMNH 20097), EHT 11107, 11128 (UIMNH 20099, 20106), nr. Acapulco, Guerrero, Mex.; *Anolis gadovi* Boulenger: EHT 22913, 22922 (UIMNH 20113, 20110), Tierra Colorado, Guerrero, Mex.; *Anolis lemurinus bourgeaei* Bocourt: EHT 11065, 11074, 11080 (UIMNH 20029, 20032, 20034), near Tapchula, Chiapas, Mex.; *Anolis megapholidotus* Smith: EHT 11145, 11148 (UIMNH 20121, 20122), near Agua del Obispo, Guerrero, Mex.; *Anolis nebuloides* Bocourt: EHT 11130 (UIMNH 20119), 2 mi. S Garrapatas, Guerrero, Mex.; EHT 11139 (UIMNH 20118), near Tierra Colorado, Guerrero, Mex.; EHT 15263 (UIMNH 20023), Cuernavaca, Morelos, Mex.; *Anolis sericeus* Hallowell: UIMNH 3975, 2 km. SW Tihuatlan, Veracruz, Mex.; EHT 11173, 11185 (UIMNH 20040, 20044), near Tapachula, Chiapas, Mex.; EHT 11188 (UIMNH 20045), Tonalá, Chiapas, Mex.; REO 5237, near Palenque, Chiapas, Mex.

BASILISCUS

Basiliscus vittatus Wiegmann: EHT 14295 (UIMNH 20283), Tres Brazos, Campeche, Mex.; REO 5500, 8 mi. W Chetumal, Quintana Roo, Mex.; REO 5533, 5534, 3.3 mi. SW Belmopan, Cayo Dis., Belize.

CALLISAURUS

Callisaurus draconoides ventralis Hallowell: EHT 309 Sonora, Mex.; EHT 455 near Guaymas, Sonora, Mex.; *Callisaurus draconoides inusitatus* Dickerson: UIMNH 34820, near Noria, Sonora, Mex.; UIMNH 34821-822, near Hermosillo, Sonora, Mex.; UIMNH 34827, La Rosa, near San Carlos Bay, Guaymas, Sonora, Mex.; UIMNH 33204, 30 mi. S Noria, Sonora, Mex.; UIMNH 33205, 2 mi. W La Rosa, near Guaymas, Sonora, Mex.

COPHOSAURUS

Cophosaurus texanus Troschel: EHT 1339, 21236, no data; EHT 1363, 1.5 mi. W Saltillo, Coahuila, Mex.; EHT 1372, 30 mi. W Coahuila Mex.; EHT 27056, 6 mi. W Monterrey, Nuevo Leon, Mex.

CORYTOPHANES

Corytophanes hernandezi (Weigmann): UIMNH 4000, 1 mi. S Tlapacoyan, Veracruz, Mex.

CROTAPHYTUS

Crotaphytus collaris (Say): UIMNH 20330, Cedar Creek, Douglas Co., Kansas; UIMNH 20331-332, near Manhattan, Pottawatomie Co., Kansas; *Crotaphytus reticulatus* Baird: EHT 19802, Arroyo Los Olmos, 3 mi. SE Rio Grande City, Starr Co., Texas; REO 606, 12 mi. N Freer, McMullen Co., Tex.; *Crotaphytus silus* Stejneger: FMNH 1250 (3), Rose Station, California; *Crotaphytus insularis*: REO 2690-2691, 2 mi. W Townes Pass, Inyo Co., Calif.; *Crotaphytus wislizenii* (Baird and Girard): UIMNH 1984, 1989, White Valley, 65 mi. W Delta, Millard Co., Utah; UIMNH 1997-1998, 20 mi. W Nephi, Juab Co., Utah; REO 2803-2805, Rome, Malheur Co., Oregon; REO 2900, 20 mi. N Winnemucca, Humboldt Co., Nevada.

CTENOSAURA

Ctenosaura similis (Gray): EHT 8553, Palenque, Chiapas, Mex.; EHT 18626, 18629, Tonala, Chiapas, Mex.; REO 5552, 10.6 mi. NW Lerdo de Tejada, Veracruz, Mex.; REO 5566, 4 mi. WSW Belize City, Belize Dist., Belize; *Ctenosaura acanthura* (Shaw): UIMNH 1595 4 mi. W Forlon, Tamaulipas, Mex.; EHT 3755, 10 mi. E San Juan de la Punta, Veracruz, Mex.; *Ctenosaura pectinata* Wiegmann: UIMNH 6766 Apatzingan, Michoacan, Mex.; UIMNH 12318 Tehuantepec, Oaxaca, Mex.; UIMNH 19848, 20 km. N Mexcala, Guerrero, Mex.; UIMNH 19851, Cachumilpa, Guerrero, Mex.; REO 11458-459, San Pedrito (near Huetamo), Michoacan, Mex.; *Ctenosaura hemilopha* (Cope): USNM 12263, 64557, 64558-559, Baja Calif., Mexico.

DIPSOSAURUS

Dipsosaurus dorsalis Baird and Girard: UIMNH 5945, 1.2 mi. W Colorado R., Yuma Co., Ariz.; UIMNH 33235, near San Carlos Bay, Baja Calif., Mex.

ENYALIOSAURUS

Enyaliosaurus quinquecarinatus (Gray): UIMNH 52510-512, 52514, Tehuantepec, Oaxaca, Mex.; *Enyaliosaurus clarki* Bailey: USNM 21452, Nopiches, Mex.; *Enyaliosaurus defensor* (Cope): Balchacaj, Campeche, Mex.

HOLBROOKIA

Holbrookia maculata thermophila Barbour: UIMNH 33255, 30 mi. S Noria, Sonora, Mex.; UIMNH 33253, Miramar, Guaymas, Sonora, Mex.; 33251, 53 mi. S Nogales, Sonora, Mex.; UIMNH 33252, near Corral, Sonora, Mex.; *Holbrookia propinqua* (Baird and Girard): UIMNH 20369-370, Benton, Atascosa Co., Texas; UIMNH 20372, Padre Island, Texas; UIMNH 33254, Lexington, Cleveland Co., Oklahoma.

IGUANA

Iguana rhinolopha Wiegmann: UIMNH 19855, Piedras Negras, Guatemala; REO 11448, loc. unknown.

LAEMANCTUS

Laemactus serratus Cope: REO 11452, 3 mi. S Dziuche, Quintana Roo, Mex.; FMNH 36484, Chichen Itza, Yucatan, Mex.; *Laemactus alticoronatus* Cope: FMNH 49266 Tecoma, Yucatan Mex.

PETROSAURUS

Petrosaurus thalassinus (Cope): USNM 15591, Baja Cal., Mex.; USNM 58277-278, San Lazaro Mts., Baja Cal., Mex.

PHRYNOSOMA

Phrynosoma orbiculare (Linnaeus): UIMNH 30346, 5 mi. W Perote, Veracruz, Mex.; UIMNH 30348, near Tulancingo, Hidalgo, Mex.; UIMNH 30354, Lerma, Mexico, Mex.; *Phrynosoma cornutum* (Harlan): UIMNH 2058-2061, Pecos, Reeves Co., Texas; *Phrynosoma douglassi* Bell: UIMNH 1728-1729, 10 mi. NW Mt. Washington, Linn Co., Ore.; *Phrynosoma bracomnieri* Dumeril and Bocourt: UIMNH 20408, about 10 mi. NE Tehuacan, Puebla, Mex.; *Phrynosoma modestum* Girard: FMNH 113886, Las Cruces, Dona Ana Co., New Mexico; UIMNH 24623, no data; UIMNH 24631, 6 mi. N Chisos Mts., Brewster Co., Texas; REO 1494, 25 mi. SW Marfa, Presidio Co., Texas; REO 1421, 1.4 mi. E Lajitas, Presidio Co., Texas; *Phrynosoma platyrhinos* Girard: UIMNH 3180-3182, 5 mi. S Sut-Cliiffs, Pyramid Lake, Washoe Co., Nevada; UIMNH 3187, 20 mi. N Reno, Washoe Co., Nevada; REO 2994-2995, 1 mi. E Rome, Malheur Co., Oregon; *Phrynosoma asio* Cope: UIMNH 20409, Mescal, Guerrero, Mex.; UIMNH 20411, Mescal, Balsas River, Guerrero, Mex.; UIMNH 20415, Tehuantepec, Oaxaca, Mex.; UIMNH 20412, Rancho Pozo Rio, Oaxaco, Mex.; *Phrynosoma coronatum blainvillei* (Blainville): UIMNH 168, Indio, Riverside Co., California; UIMNH 5901-5902, Banning, Riverside Co., Cal.; UIMNH 5903, 4.8 mi. E Soledad, Monterey Co., Cal.; *Phrynosoma solare* Gray: UIMNH 20439, 1 mi. W La Rosa, Sonora, Mex.; UIMNH 20439 near Empalme, Sonora, Mex.; REO 2290, 8.7 mi. NW Sells, Pima Co., Arizona; REO 2261, 32 mi. NW Sells, Pima Co., Arizona.

SATOR

Sator angustus Dickerson: USNM 64474, 64476-477, Santa Cruz Island, Baja, Cal., Mex.

SAUROMALUS

Sauromalus ater: FMNH 31015, SW.U.S.; *Sauromalus obesus* Baird: UIMNH 4457, 8 mi. W Indian Wells, Riverside Co., California; UIMNH 6030, Palm Springs, Riverside Co., Calif.; REO 4622, 5.4 mi. N entrance Agua Caliente Springs, San Diego Co., Calif.; REO 3238, 20.8 mi. W Ocotillo Wells, San Diego Co., Calif.

SCELOPORUS

Sceloporus malachiticus acanthinus Bocourt: UIMNH 21325, La Espe ranza, Chiapas, Mex.; *Sceloporus malachiticus taeniocnemis* (Cope): UIMNH 21328, Mt. Obando, Chiapas, Mex.; *Sceloporus formosus* Wiegmann: UIMNH 20831, above Acultzingo, Veracruz, Mex.; UIMNH 20842, Cerro San Felipe, Oaxaca, Mex.; UIMNH 20832, Acultzingo, Veracruz, Mex.; UIMNH 20834, 2 mi. S Acultzingo, Veracruz, Mex.; *Sceloporus asper* Boulenger: UIMNH 20475-476, near Uruapan, Michoacan, Mex.; *Sceloporus stejnegeri* Smith: UIMNH 27422-473, Tierra Colorado, Guerrero, Mex.; *Sceloporus serrifer prezygus* Smith: UIMNH 8772, 8775, 9 mi. E Las Rosas, Chiapas, Mex.; UIMNH 8777-8778, 12 mi. E Las Rosas, Chiapas, Mex.; *Sceloporus serrifer serrifer* Cope: UIMNH 21551-552, 21554, 21558, Merida, Yucatán, Mex.; *Sceloporus serrifer cyanogenys* Cope: UIMNH 20817, Rio Grande City, Starr Co., Texas; UIMNH 20818, Zapata, Zapata Co., Texas; UIMNH 20820, REO 1663-1667, UIMNH 33266, Arroyo Los Olmos, 3 mi. SE Rio Grande City, Starr Co., Texas; *Sceloporus lundelli* Smith: UIMNH 27266-267, Balchacaj, Campeche, Mex.; *Sceloporus edwardtaylori* Smith: UIMNH 10572-573, 10575-576, Tehuantepec, Oaxaca, Mex.; *Sceloporus melanorhinus* Bocourt: UIMNH 2135, between Zapotitlan and Santa Lucia, Oaxaca, Mex.; UIMNH 21384, Cerro Guengola, Oaxaca, Mex.; UIMNH 33274, Paso del Rio, Colima, Mex.; REO 3575, 8 mi. ESE Acapulco, Guerrero, Mex.; *Sceloporus clarki* (Baird and Girard): UIMNH 33262, 53 mi. S Nogales, Sonora, Mex.; UIMNH 33263, 30 mi. S Noria, Sonora, Mex.; UIMNH 33261, Presidio, 50 mi. S Mazatlan, Sinaloa, Mex.; UIMNH 20549, at Presidio, Sinaloa, Mex.; UIMNH 20551, 8-10 km. S Presidio, Sinaloa, Mex.; UIMNH 20552, 1 mi. E Mazatlan, Sinaloa, Mex.; *Sceloporus magister* Hallowell: UIMNH 1892-1893, 24.8 mi. NE Puerto Penasco, Sonora, Mex.; *Sceloporus horridus* Wiegmann: EHT 8641, 8647, 12 mi. S Chilpancingo, Guerrero, Mex.; EHT 27393 15 mi. S Zacualtipan, Hidalgo, Mex.; REO 3473, 3.1 mi. E Colima, Colima, Mex.; EHT 27399 near Cd. Mante, Tamaulipas, Mex.; EHT 27398 road to Perote, Veracruz, Mex.; UIMNH 21164, near Magdalena, Jalisco, Mex.; UIMNH 21166, near Queseria, Colima, Mex.; UIMNH 21169, 21175, Hacienda El Sabino, near Uruapan, Michoacan, Mex.; *Sceloporus spinosus* Wiegmann; UIMNH 4002-4003, 2 mi. NW Ixmiquilpan, Hidalgo, Mex.; REO 5855, 1.9 mi. NE Miguel Hidalgo, Tamaulipas, Mex.; REO 6074, 3 mi. SE Zimapan, Hidalgo, Mex.; REO 5131, 34.5 rd. mi. S Cuesta Colorado, Hidalgo, Mex.; *Sceloporus olivaceus* Smith: UIMNH 4050, Horse Tail Falls, 25 mi. S Monterey, Nuevo Leon, Mex.; UIMNH 4051, 28 mi. W China, Reynosa-Monterey Hwy, Nuevo Leon, Mex.; UIMNH 4052-4053, 14 mi. N Villagran, Tamaulipas, Nuevo Leon, Mex.; *Sceloporus occidentalis longipes* Baird: UIMNH 254, Brea, Orange Co., Calif.; UIMNH 2033-2035, House Range, 65 mi. W Delta, Millard Co., Utah; *Sceloporus undulatus consobrinus* (Baird and Girard): EHT 13066, 13072, 13075, no data; UIMNH 21920, 11 mi. W Dilley, Frio Co., Texas; UIMNH 21919, Benton, Atascosa Co., Texas; UIMNH 21924, 21926, 11 mi. W Dilley, Frio Co., Texas; UIMNH 33292, Kirns Place, Benton, Atascosa Co., Texas; *Sceloporus woodi* Stejneger: UIMNH 21953, Carnegie Mus. Exp.; *Sceloporus graciosus* (Baird and Girard): UIMNH 2017, House Range, 65 mi. W Delta, Millard Co., Utah; UIMNH 2019, 1026-2027, White Valley, 75 mi. W Delta, Millard Co., Utah; REO 2753-2759, 5 mi. E Hampton, Deschutes Co., Oregon; REO 495-497, Dairy Creek Guard Stn., ca 20 mi. W Paisley, Lake Co., Oregon; *Sceloporus grammicus* Wiegmann: UIMNH 10709, 10714, 10716, 10718, San Pedro, Quiechapa, Oaxaca, Mex.; UIMNH 33279, Tres Marias, Morelos, Mex.; UIMNH 33278, Lake Zempoala, Morelos, Mex.; UIMNH 20990, near Minas Viejas, Veracruz, Mex.; UIMNH 21000-001, 13 mi. SE Rio

Grande City, Starr Co., Texas; UIMNH 20991, Rio Grande City, Starr Co., Texas; *Sceloporus megalepidurus* Smith: EHT 5943, 55 mi. E Perote, Veracruz, Mex.; UIMNH 33275-33277, 15 mi. E San Marcos, 55 mi. W Perote, Veracruz, Mex.; REO 5874, 9.1 mi. WSW Perote, Veracruz, Mex.; *Sceloporus pictus* Smith: UIMNH 21447, about 22 km. N Tlacotepec, Puebla, Mex.; UIMNH 21448-449, near Tehuacan, Puebla, Mex.; *Sceloporus mucronatus* Cope: UIMNH 21332, near Toxtacuaya, Veracruz, Mex.; UIMNH 21367, 5 mi. W Perote, Veracruz, Mex.; UIMNH 21355, 2 mi. W La Joya, Veracruz, Mex.; UIMNH 21350, Totalco, Veracruz, Mex.; *Sceloporus poinsetti* Baird and Girard: UIMNH 21459, near Pedriceña, Durango, Mex.; UIMNH 21461, REO 4136, 6 mi. NE Pedriceña, Durango, Mex.; UIMNH 21463, 10 mi. S Moctezuma, Chihuahua, Mex.; UIMNH 33285, Alpine, Brewster Co., Texas; *Sceloporus torquatus* Wiegmann: UIMNH 10867-68, 10872, Zempoala, Morelos, Mex.; UIMNH 33290, REO 3503, 3658, Lagunas de Zempoala, Morelos, Mex.; *Sceloporus jarrovi* Cope: FMNH 100174, UIMNH 21319, 6 mi. NE Pedriceña, Durango, Mex.; UIMNH 33272, NE Pedriceña, Durango, Mex.; UIMNH 5947, 5952, Carr Canyon, Huachuca Mts., Cochise Co., Ariz.; UIMNH 6040, 6042, 15 mi. S Fort Huachuca, Cochise Co., Ariz.; *Sceloporus ornatatus* Baird: UIMNH 21452, 1.5 mi. W Saltillo, Coahuila, Mex.; UIMNH 21453, 5 mi. S San Pedro, Coahuila, Mex.; *Sceloporus dugesi* Bocourt: UIMNH 20877, 20879, 20881, Magdalena, Jalisco, Mex.; UIMNH 20884, 3 mi. NE Autlán, Jalisco, Mex.; *Sceloporus cozumelae* Jones: UIMNH 20590-591, Progreso, Yucatan, Mex.; *Sceloporus teapensis* Gunther: UIMNH 21586-586, San Andres Tuxtla Veracruz, Mex.; EHT 7679, no data; UIMNH 21590, La Gloria, Oaxaca, Mex.; *Sceloporus variabilis* Wiegmann: UIMNH 4023-4024, 36 mi. N Cd. Mante, Tamaulipas, Mex.; UIMNH 33299, Viejo, San Luis Potosi, Mex.; EHT A942, 36 mi. N Falfurrias, Brooks Co., Texas; EHT A957, Arroyo El Salada, 13 mi. SE Rio Grande City, Starr Co., Texas; UIMNH 22019, Texas; UIMNH 22022, Helotes, Bexar Co., Texas; *Sceloporus parvus scutulatus* Smith: UIMNH 21441-442, Mts. beyond San Francisco, Hidalgo, Mex.; UIMNH 21443-444, 5 mi. S Zacualtipan, San Luis Potosi, Mex.; *Sceloporus couchi* Baird: UIMNH 20553, 20556, 20558, 33264, near Sabinas Hidalgo, Nuevo Leon, Mex.; *Sceloporus maculosus* Smith: UIMNH 27421, REO 4139-4140, 6 mi. NE Pedriceña, Durango, Mex.; REO 4135, 9.8 mi. SW Picardias, Durango, Mex.; *Sceloporus chrysostictus* Cope: UIMNH 20529, Progreso, Yucatan, Mex.; UIMNH 20533-534, Cd. del Carmen, Campeche, Mex.; EHT 13071, Tres Brazos, Campeche, Mex.; *Sceloporus siniferus* Cope: UIMNH 21514, 1 mi. N Naranjos, Guerrero, Mex.; UIMNH 21547, near Tonalá, Chiapas, Mex.; UIMNH 21531, 4 mi. N Acapulco, Guerrero, Mex.; UIMNH 33289, Agua del Obispo, Guerrero, Mex.; *Sceloporus squamosus* Bocourt: UIMNH 21580-581, near Tapachula, Chiapas, Mex.; *Sceloporus carinatus* Smith: UIMNH 8680, Trinitaria, Chiapas, Mex.; UIMNH 8681, 1 mi. NW Teopisco, Chiapas, Mex.; *Sceloporus ochoterena* Smith: UIMNH 21404, Puente de Ixtla, Veracruz, Mex.; UIMNH 33283, 1 mi. N Naranjos, Guerrero, Mex.; *Sceloporus utiformis* Cope: UIMNH 33295, near Queseria, Colima, Mex.; UIMNH 33293-295, Paso del Río, Colima, Mex.; UIMNH 33297, near Chapala, Jalisco, Mex.; REO 3449, 4.1 mi. W Tepic, Nayarit, Mex.; REO 3454, 10.5 mi. WNW Santiago, Colima, Mex.; *Sceloporus jalapae* Gunther: UIMNH 21185, 21187, 21190, Lake El Chico, Hidalgo, Mex.; UIMNH 21181, between Zumbilla and Laguna San Bernardino, Veracruz, Mex.; REO 759, 762, 1.5 mi. WSW Puerto del Aire, Puebla, Mex.; *Sceloporus aeneus* Wiegmann: UIMNH 33260, near Tres Marias, Morelos, Mex.; UIMNH 20509, Noharachic, Chihuahua, Mex.; UIMNH 20510, 10 mi. S Mexico City, D.F., Mex.; UIMNH 20520, Cruz Blanca, Veracruz, Mex.; UIMNH 20502, Mt. Ajusco, Morelos, Mex.;

Sceloporus scalaris Wiegmann: UIMNH 21506, near Lake Cuitzeo, Michoacan, Mex.; UIMNH 21509, near Acambaro, Guanajuato, Mex.; UIMNH 21510, east end of Lake Chapala, Michoacan, Mex.; UIMNH 33288, Lake Zempoala, Morelos, Mex.; *Sceloporus gadovae* Boulenger: UIMNH 20971, Mexcala on Balsas, Guerrero, Mex.; UIMNH 20985, 20988, Hacienda El Sabino, Michoacan, Mex.; UIMNH 33269, near Mexcala, Guerrero, Mex.; UIMNH 33268, Agua del Obispo, Guerrero, Mex.; REO 3524, 17.5 rd. mi. N Chilpancingo, Guerrero, Mex.; REO 3525, 8.6 mi. S Iguala, Guerrero, Mex.; *Sceloporus pyrocephalus* Cope: UIMNH 33286, Paso del Rio, Colima, Mex.; UIMNH Hac. Paso del Rio, Colima, Mex.; REO 3474-3475, 10 mi. E Colima, Colima, Mex.; *Sceloporus nelsoni* Cochran: UIMNH 33282, Mt. San Juan, Tepic, Nayarit, Mex.; UIMNH 33280-281, near Ixtlan, Nayarit, Mex.

STREPTOSAURUS

Streptosaurus mearnsi (Stejneger): USNM 69826, 69829-830, Andreas Canyon, Riverside Co., Calif.; REO 4624-4627, 5.4 mi. N Agua Caliente Springs, San Diego Co., Calif.

UMA

Uma exsul Schmidt and Bogert: FMNH 44302, 44305, Dunes 12 mi. N San Pedro, Coahuila, Mex.; *Uma notata* Baird: FMNH 26180, 26186, Imperial Co., Cal.; REO 3118, 6.1 mi. S Salton City, Imperial Co., Cal.; *Uma scorparia* Cope: FMNH 1203, Dagget, Cal.; FMNH 39439, Central San Bernardino Co., in mts. about 25 mi. E Yermo, Cal.; *Uma inornata* Cope: FMNH 68848, Cathedral City, Riverside Co., Cal.

UROSAURUS

Urosaurus ornatus Baird and Girard: UIMNH 2642, 2645, Marshall Ford Reservoir, South Shore, Travis Co., Texas; UIMNH 4968, Nance Ranch, Hays Co., Texas; *Urosaurus microscutatus* (Van Denburgh): FMNH 1053, Canyon Esparanza, Baja, Calif., Mex.; FMNH 1054, Matoni, Baja Calif.; Mex. *Urosaurus gadovae* Schmidt: FMNH 36895, Apatzingan, Michoacan, Mex.; FMNH 38956, 38957, Acahuato, Apatzingan, Michoacan, Mex.; *Urosaurus auriculatus* (Cope): FMNH 18407, Socorro Id., Revillagigedo Ids., Mex.; *Urosaurus bicarinatus bicarinatus* (Dumeril): UIMNH 11122, 11128-129, 5 km. S Cuernavaca, Morelos, Mex.

UTA

Uta stansburiana (Baird and Girard): UIMNH 22101, 22103-104, Utah; *Uta stellata* Van Denburgh: FMNH 19172, West San Benito Id., Mex.; FMNH 19173, East San Benito Id., Mex.; FMNH 19174, Asuncion Id., Mex.; *Uta taylori* Smith: UIMNH 33328-330, near San Carlos Bay, 2 mi. W La Posa, near Guaymas, Sonora, Mex.

Scincidae

Eumeces obsoletus (Baird and Girard): UIMNH 33241, 9 mi. NW Lawrence, Jefferson Co., Kansas; UIMNH 33242, Meade Co., Kansas, *Eumeces copei* Taylor: EHT 22589, Rio Frio, Mexico, Mex.; UIMNH 33238, Lagunas de Zempoala, Morelos, Mex.; *Eumeces fasciatus* (Linnaeus): UIMNH 33239-240, 9 mi. NW Lawrence, Jefferson Co., Kansas.

Teiidae

AMEIVA

Ameiva festiva edwardsi Bocourt and Mortens: UIMNH 11349, 11352, 11353, 11357, Peten, Guatemala; *Ameiva undulata parva* Barbour and Noble: UIMNH 11397, 11404, 11409, 11417, 11430, Chiapas, Mex.; REO 5947, 5.4 mi. SE Cardel, Veracruz, Mex.

CNEMIDOPHORUS

Cnemidophorus deppei Wiegmann: UIMNH 33207, near Totolpam, Oaxaca, Mex.; REO 3483-3485, 12.3 mi. ESE Acapulco, Guerrero, Mex.; UIMNH 33208-209, Paso del Rio, Colima, Mex.; *Cnemidophorus communis* Cope: UIMNH 13462, near Queseria, Colima, Mex.; UIMNH 19745-746, 13486, near Manzanillo, Colima, Mex.; UIMNH 21094, around Mexico City, D.F., Mex.; UIMNH 33212-213, Paso del Rio, Colima, Mex.; UIMNH 33226, Ixtlan, Nayarit, Mex.; *Cnemidophorus mexicanus*: UIMNH 33211, near Totolpam, Oaxaca, Mex.; *Cnemidophorus burti* Taylor: FMNH 100004, near La Posa, 10 mi. NE Guaymas, Sonora, Mex.; FMNH 72173, no data; *Cnemidophorus sexlineatus* (Linnaeus): UIMNH 945, 4 mi. S Lake Village, Newton Co., Indiana; UIMNH 2086-2087, Dunes St. Park, Porter Co., Ind.; UIMNH 2234, Kankakee Dunes, 5 mi. E Lake Village, Newton Co., Ind.; *Cnemidophorus tigris aethiops* Cope: UIMNH 33214, 30 mi. S Noria, Sonora, Mex.; UIMNH 33216, 5 mi. SW Hermosillo, Sonora, Mex.; UIMNH 33215, near Guaymas, Sonora, Mex.; *Cnemidophorus* sp.: UIMNH 33220, no data; UIMNH 33224, near Sebastian, Hidalgo Co., Tex.; UIMNH 33228, 33230, 11 mi. S Puente de Ixtla, near Huajintlan, Morelos, Mex.; UIMNH 33229, Mt. San Juan, near Tepic, Nayarit, Mex.; UIMNH 33222, 1 mi. N Organos, Guerrero, Mex.; UIMNH 33219, 33227, 33217, no data.

GYMNOPHTHALMUS

Gymnophthalmus speciosus sumichrasti (Cope): UIMNH 3763, Escurana, Oaxaca, Mex.; UIMNH 6126, Cerro San Pedro, near Tehuantepec, Oaxaca, Mex.

Helodermatidae

HELODERMA

Heloderma suspectum Cope: UIMNH 33250, by Bond in Southwest U.S.; UIMNH 33248 (2), 33249 (2), no data; *Heloderma horridum*: REO, badly damaged specimen in field, 11 mi. WSW Concordia, Sinaloa, Mex.

Literature Cited

NOTE: This literature cited section includes only titles not mentioned in the Part I report (q.v.).

Olson, R. E.

(In press) Taxonomic Relationships of the lizards *Sceloporus serrifer* and *S. cyanogenys* of the Gulf Coastal Plain.

Olson, R. E., B. Marx and R. Rome.

1986. Descriptive dentition morphology of lizards of Middle and North America I: Scincidae, Teiidae, and Helodermatidae. Bull. Maryland Herp. Soc. 22(3):97-124, 32 figs.

Smith, H. M. and R. Smith.

1976. Synopsis of the herpetofauna of Mexico. John Johnson, North Bennington, Vt. Vol. III.

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NEW BOOK NEWS:

SNAKES: ECOLOGY AND EVOLUTIONARY BIOLOGY

Edited by

Richard A. Seigel, Savannah River Ecology Laboratory,
Joseph T. Collins, Museum of Natural History, University of Kansas,
Susan S. Novak, Savannah River Ecology Laboratory

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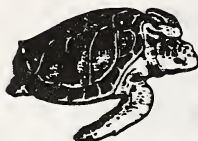
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1987 SEASON

Departures for the 13 day program, including a trip to the Monteverde Cloud Forest, are:

July 6, 13, 20, 27

August 3, 10, 17, 24

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The International Trust for Zoological Nomenclature is publishing a revised and updated edition of the Official Lists. Copies will be available in the United States from the AAZN, at a cost of \$100 to members, \$110 to non-members. Order forms will be mailed in March.

New Format for Bulletin of Zoological Nomenclature

The BZN has been completely redesigned for 1987, and the first issue in the new format is due out in March. The new Bulletin will contain general articles on nomenclature and its relevance to systematics. The first issue will include a short note on the AAZN. Brochures describing the new Bulletin will be mailed in March.

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Errata: BMHS 22(3):146-148.
Egg dimensions in Table 1
should be corrected by multiplying
by a factor of 0.915 to correct for
8½% enlargement due to shadow effect.

NEWS AND NOTES:



**11th INTERNATIONAL HERPETOLOGICAL SYMPOSIUM
On Captive Propagation and Husbandry
Chicago, Illinois
June 17-20, 1987**

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Sincerely,

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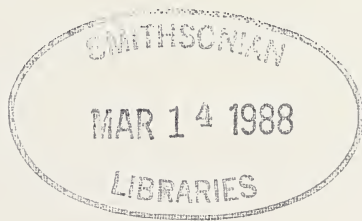


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DEPARTMENT OF HERPETOLOGY
THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.



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Volume 23 Number 2

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SEASONAL VARIATION IN FAT BODIES OF THE MONTANE
LIZARD, *Sceloporus scalaris*^{*}Alfredo Ortega, Ricardo Rodríguez,
Patricia Galina, and América GutiérrezAbstract

At La Michilla Biosphere Reserve, Durango, México, monthly variations in the mass of fat bodies from males and females of a *Sceloporus scalaris* population were studied. In males, these tissues were small from April to September. Females exhibit an abrupt decrease in fat body mass from April to June. Fat body cycles are strongly influenced by the marked seasonality of the zone but also by the chronology and synchrony of the reproductive cycle of this species. In females, these tissues decrease during ovarian vitellogenesis suggesting they are an energy source during this period. These lipid however are used by males during territorial expansion and mating periods.

Fat storage in abdominal vesicles is a very common phenomenon in lizards. The vast literature concerning this accumulation of energy reserves indicates that it occurs mainly in temperate zone species (Derickson, 1976), but in tropical species evidence of its occurrence have been found as well (Chapman & Chapman, 1963; Derickson, 1976; Simbotwe, 1980; Smith, 1968): Furthermore, literature indicates that the energy stored in fat-bodies is used for such seasonal activities as reproduction (Hahn & Tinkle, 1965; Licht & Gorman, 1970; Telford, 1970) and hibernation (Derickson, 1974; Goldberg, 1972).

Sceloporus scalaris Wiegmann is a small (52-62 mm S.V.L.) oviparous lizard widely distributed in central and northern Mexico. The reproductive cycle of individuals from one population of this species in Durango, Mexico, has been presented previously (Ortega and Barbault, 1986). Females begun vitellogenesis in late March, ending in early May. Ovulation occurs during mid or late May and egg laying takes place in June. For oldest individuals a second reproductive period is evident in June; vitellogenesis and ovulation takes place in June and July, and a second clutch occurs in August. Males exhibit maximal testicular activity from March to May. Maximum testicular

^{*}This work is part of the studies carried out in the La Michilla Biosphere Reserve (MAB-UNESCO Program).

Key words: *Sceloporus scalaris*, fat-body cycles, reproductive cycles, lizards. México.

and ovarian activities occur synchronously. Individuals of this population are active throughout the year. In this study we investigate the seasonal fat-body cycles of males and females of this population by analyzing the probable causes that determine them and by comparison with lipid cycles in other populations of the same and other species.

Materials and methods. From December 1980 to December 1981, monthly collections of 5 to 10 adults *S. scalaris* of each sex were obtained within a 5 Km radius of the Instituto de Ecología field station at the Michilla Biosphere Reserve in the State of Durango, Mexico (104°07' - 104°20' W; 23°20' - 23°30'N), 2480 m. The area has a mean annual temperature range between 17.4°C and 20.7°C and received approximately 567 mm of annual precipitation. The habitat is characterized as an Oak-Pine forest.

Each monthly collection was made within a period of 3 to 4 days. The lizards were captured by hand and taken to the laboratory station and processed within 12 hours. Each lizard was weighed to 0.01 g. with an electronic balance and the snout-vent and tail lengths were measured to 0.1 mm using a vernier. Individuals were killed with Nembutal and before fixation, gonads and fat-bodies were extracted for analysis. Fat-bodies were weighed to 0.001 g. using an electronic balance. An analysis of covariance with snout-vent length as the covariate was performed to determine association between fat-body mass and SVL and to adjust means of monthly fat-body mass. Gonads and fat-bodies were fixed in Bouin's solution and specimens in 70% alcohol solution. These are kept in the vertebrate collection at the Instituto de Ecología in Mexico City.

Results. The analysis of covariance with SVL as the covariate revealed that fat-body mass in males is associated with SVL ($r^2 = 0.53$; $F_{11,63} = 18.24$, $P < 0.001$) and thus least square means were calculated on a monthly basis in order to examine seasonality in the amount of the energy reserves in the abdominal vesicles. Males exhibit a rapid decline in fat-body mass from January to April and they remain depleted until September (Fig. 1). Between November and December fat-body mass increases steeply and in December exhibits maximum size. Testicular development is not correlated with a decrease in fat-body mass (January to June; $r = -0.863$; $y = 0.19x - 2.31$; $t = 2.38$; N.S.).

Analysis of covariance with SVL as the covariate was used to adjust means of monthly females fat-body mass, since there is a significant effect of body size on fat-body mass ($r^2 = 0.53$; $F_{11,72} = 33.21$, $P < 0.001$). Female fat-body mass tended to decline from April to June and remained low until October (Fig. 2). As in the case of the males, from October to December fat-body mass increases rapidly and reaches a maximum size in December. An apparent inverse relationship between both ovarian and fat-body cycles may be observed from April to June, but no correlation exists as t is small ($r = -0.562$; $y = 0.19x - 0.63$; $t = 0.96$; N.S.).

Discussion. The abrupt decrease in female fat-body mass from April to June may be due to yolk deposition, as these energy reserves are believed to be transferred to the ovary via vitellogenesis. After the second oviposition

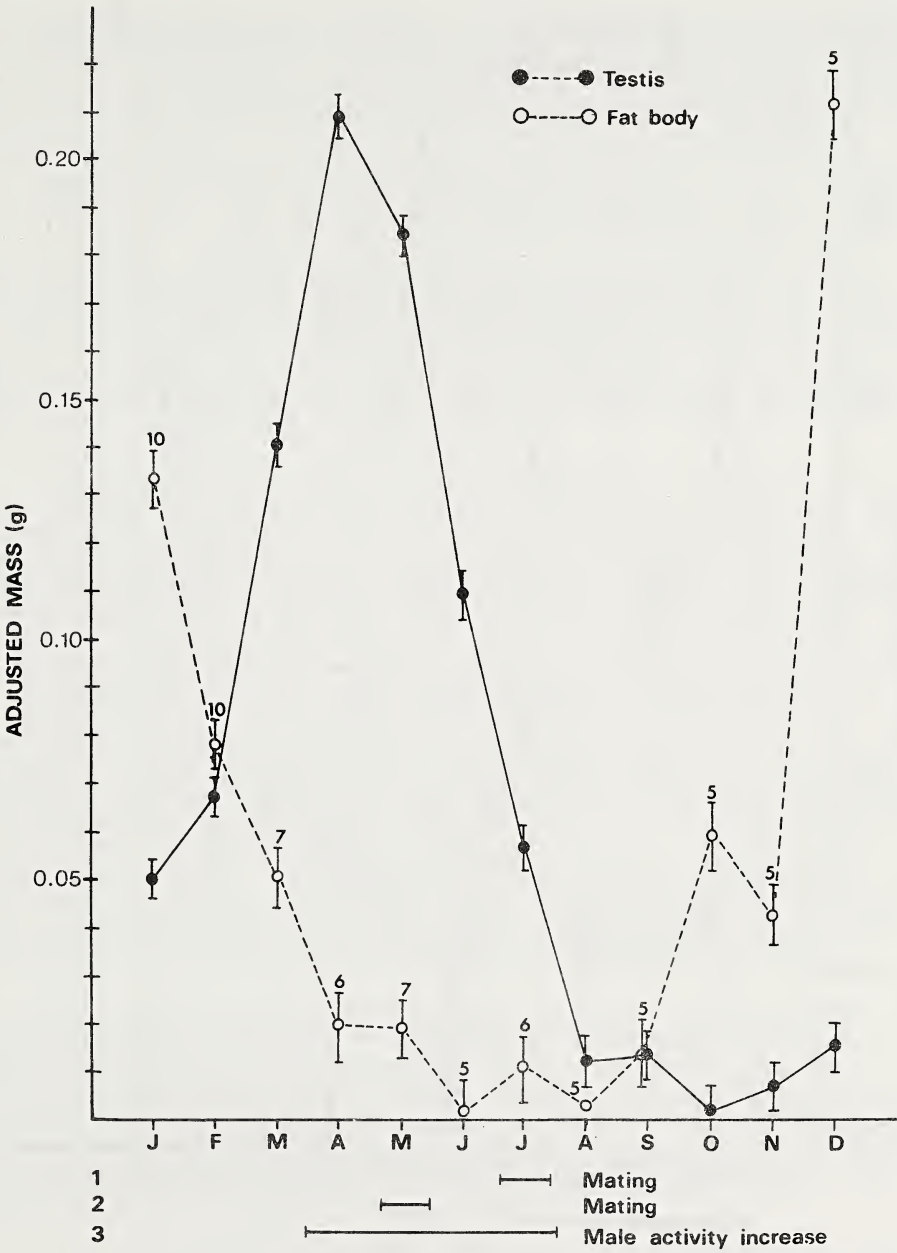


Fig. 1 - Annual cycle of adjusted fat-body mass and adjusted testicular mass for male *Sceloporus scalaris*. Circles represent the mean and bars the standard deviation (number above the bars are sample sizes).

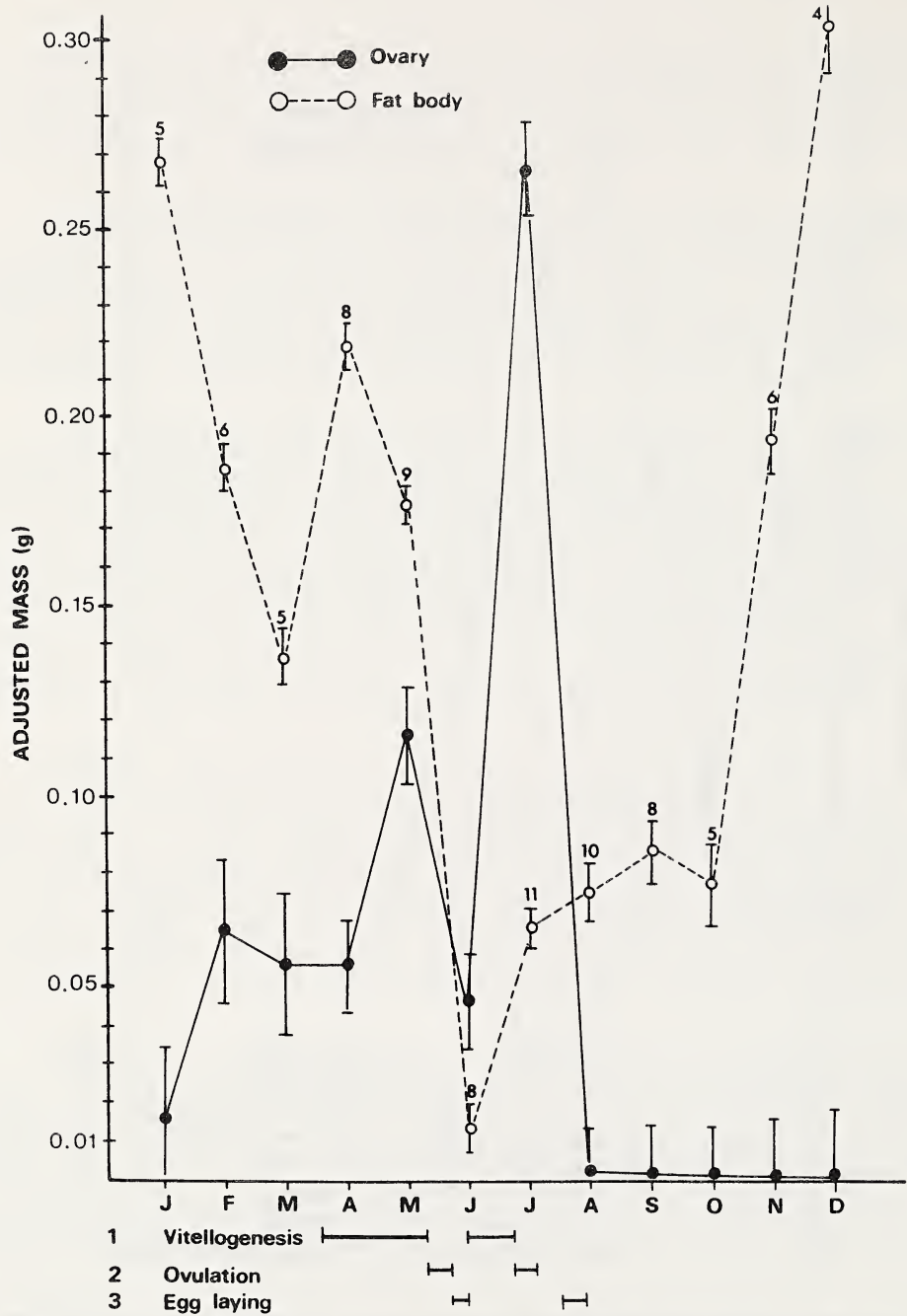


Fig. 2 - Annual cycle of adjusted fat-body mass and adjusted ovarian mass for female *S. scalaris*. Explanation as in Fig. 1.

period female fat-body mass increases. This could be due to the completion of reproductive activity and also because this is the period of high food abundance at La Michilla (Ortega and Hernández, 1983). The data for the female cycle agree with reports for females of other *Sceloporus* species (*S. occidentalis*, Jameson & Allison, 1976; *S. graciosus*, Derickson, 1974; Jameson, 1974; which are oviparous and mountain species) as well as with other females of the same species studied at Arizona (Ballinger & Congdon, 1981; Newlin, 1976). The females of all the aforementioned species have small fat-bodies in June and July. After this period fat-bodies start growing until the end of the year or until the time when they are active (since individuals of some species hibernate before December). In every case the depletion of female fat-bodies is associated with ovarian vitellogenesis, but this depletion is not complete. This pattern is similar to the pattern reported for females of other lizard species (Ballinger, 1971; Goldberg, 1970; Guillette y Casas-Andreu, 1981; Hahn and Tinkle, 1965; Marion and Sexton, 1971; Minnich, 1971; Telford, 1970).

Sceloporus scalaris males in Michilla exhibit low fat-body values from April to September, during the dry season. Furthermore, during this period, the males of this population show a noteworthy increase of activity. They become much more aggressive and conspicuous and have greater home ranges. In May and June courtship and mating occur (Gutiérrez, 1983). Thus, an increase in energy expenditure by the males used to establish, increase, patrol and defend their territories as well as to court and copulate with the females may explain the low fat-body weight values found during this period. During the last months of the year, these energy reserves increase steeply for the same reasons that have been previously explained for the females; that is during this period food and availability for these organisms is high and there are no reproductive activities. The pattern exhibited by the males at the Michilla Reserve is similar to that observed in other montane oviparous species (*Sceloporus occidentalis*, Jameson and Allison, 1976; *S. graciosus*, Jameson, 1974), and in the males of one population of *S. scalaris* from Arizona (Newlin, 1976). All these males exhibit high fat-body weight values during the last months of the year, or until the time when they are active (since individuals of some species hibernate before December), and small lipid vesicles during the spring months in the reproductive season.

Thus, fat-body depletion in *Sceloporus scalaris* males from the Michilla Reserve is apparently correlated with an increase in activity associated with mating and territorial defense. In females from this population, lipids accumulated in these tissues are probably transferred to the ovarian follicles during vitellogenesis. This differential utilization of energy reserves between males and females of Sceloporine lizards has been previously indicated by other authors (Guillette and Casas-Andreu, 1981; Jameson, 1974; Maric, 1970).

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OBSERVATIONS OF POPULATION MOVEMENTS IN THE GALÁPAGOS GIANT TORTOISE, *Geochelone elephantopus vandenburghi*

Kent R. Beaman and Lester E. Harris, Jr.

Abstract

Population movements of the Galápagos giant tortoise, *Geochelone elephantopus vandenburghi*, were studied from September 1983 through June 1984. Twenty tortoises, 10 adult males and 10 adult females, were marked with numbers painted on the front of each carapace. The tortoises were released, and their movements were monitored over a one year period. The percent recovery of marked tortoises along with numbers of unmarked tortoises counted in sections of the study area were used to determine population movements and location. Weather data were collected and analyzed to determine what impact climate may have on tortoise movement. Population movement does occur on Volcán Alcedo and is dependent on seasonal climatic conditions and food availability.

Since the time of Charles Darwin (1835), the Galápagos giant tortoise, *Geochelone elephantopus*, has been the subject of extensive investigations (see literature review by Beaman, 1985a). Early accounts describe tortoise movements as that taking place between the highlands and the coast during the nesting period. Trails produced by the tortoises showed evidence of extensive use suggesting that these movements occur frequently (Baur, 1889; Beck, 1902; Heller, 1903; and Carpenter, 1963).

Previous reports suggest that giant tortoises frequently move in random patterns, but two important questions remain: (1) what are the factors responsible for tortoise movement, and (2) do these movements occur seasonally? The purpose of this study was to determine the extent of tortoise movement as revealed by the use of mark and recapture techniques and the effect of climatic and other ecological conditions on tortoise movement.

Study Area

Isabela, the largest island within the Galápagos Archipelago, is composed of five large volcanos, each supporting its own population of giant tortoises (Figure 1 inset). Volcán Alcedo was chosen as the study site because of the large population size and accessibility. The crater was divided into 8 sections to facilitate the counting of tortoises and monitoring their movements (Figure 1).

Climatic conditions on Volcán Alcedo are characteristic of those observed throughout the islands (Thornton, 1971; Wiggins and Porter, 1971; and Rasmusson, 1985). Varying conditions, however, occur in different areas of the crater. The north section, in addition to the middle floor, is dry. The moisture levels in these areas are quite unpredictable. Air temperatures range from 28–33°C. The southern section is characterized by southeasterly trade winds that cause clouds to build up over the rim, thus creating a

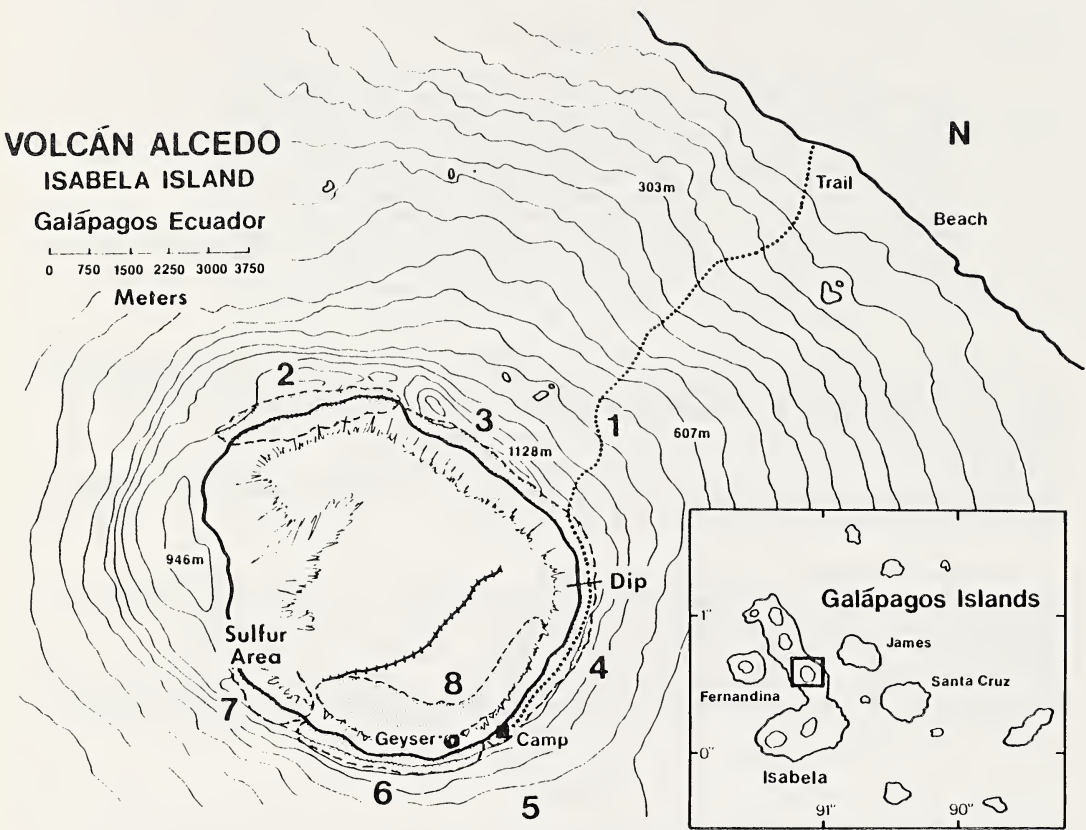


Figure 1. Map of the Volcán Alcedo study site (adapted from Servicio Parque Nacional Galápagos. 1980. Guide to the Visitor Sites of Parque Nacional Galápagos). Inset shows the major islands within the Galápagos Archipelago, with the location of Volcán Alcedo shown in the square.

higher precipitation level and cooler air temperatures ranging from 16–22°C. The east and west sections have climates intermediate between that of the dry and wet areas (Beaman, 1985b).

Methods

During the first study trip (September 1983) 10 adult male and 10 adult female tortoises were marked by painting yellow numbers on the front of each carapace. The tortoises were chosen arbitrarily, marked, and released. Tortoise movements were monitored at three different times of the year (September, December, and June) to correspond with seasonal weather patterns. During the December trip 6 additional tortoises, 3 females, 2 males, and a juvenile around the geyser area were marked (Figure 1). Unmarked tortoises were counted throughout the duration of the study in all 8 sections.

Temperature and relative humidity data were collected using a Taylor Sling Psychrometer. Observations on cloud cover were recorded and moisture levels were measured both by columetric rain gauges and area measurements of existing water ponds. These data were compared with that from other studies (see summary by Fowler, 1983) to determine the effect of climatological factors on tortoise movement.

Results

Marked tortoises were recovered 50–400 m within the area where they had been marked. Most tortoises remained on the rim, but several moved down along the outer slopes; two tortoises were not relocated. Recapture data is presented in Table 1. Of the 6 tortoises marked around the geyser area, 3 were relocated three days after being marked, 1 was relocated in the area six months later, and 2 tortoises were not relocated.

Table 1. Summary data and percentage of tortoises relocated after the initial marking.

DATE	NUMBER OF TORTOISES RECOVERED	PERCENT
Sept. 9, 1983	17/20	85%
Sept. 10, 1983	7/20	35%
Dec. 1983**	6/20	30%
June 1984**	5/20	25%

**The 11 tortoises relocated during these two trips were all marked with different numbers. Two tortoises of the original 20 were not relocated.

Unmarked tortoises were counted in each section of the study area. These data are presented in Figures 2 and 3.

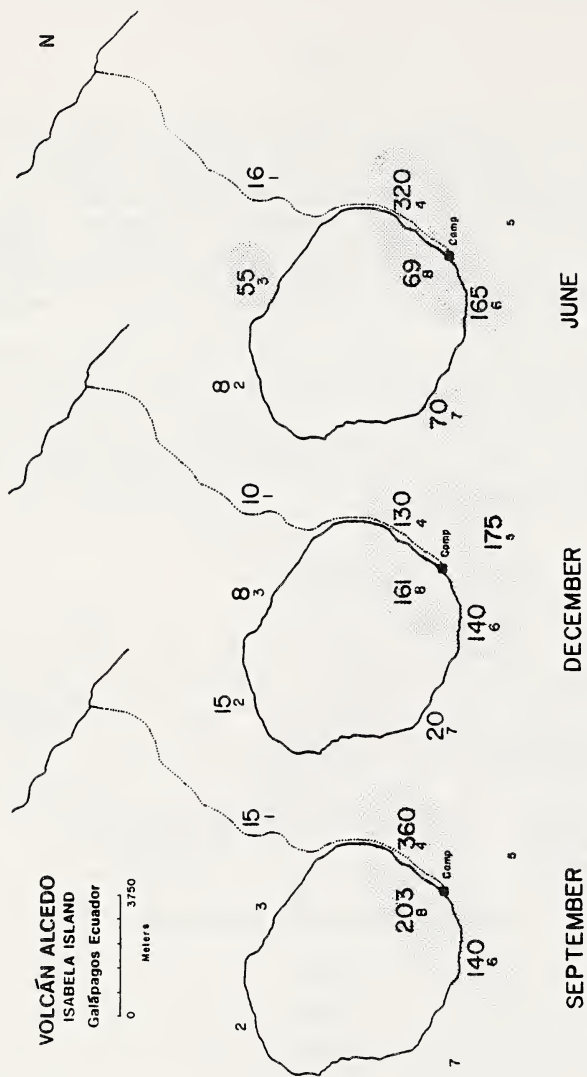


Figure 2. Map showing tortoise distribution during the three study trips.

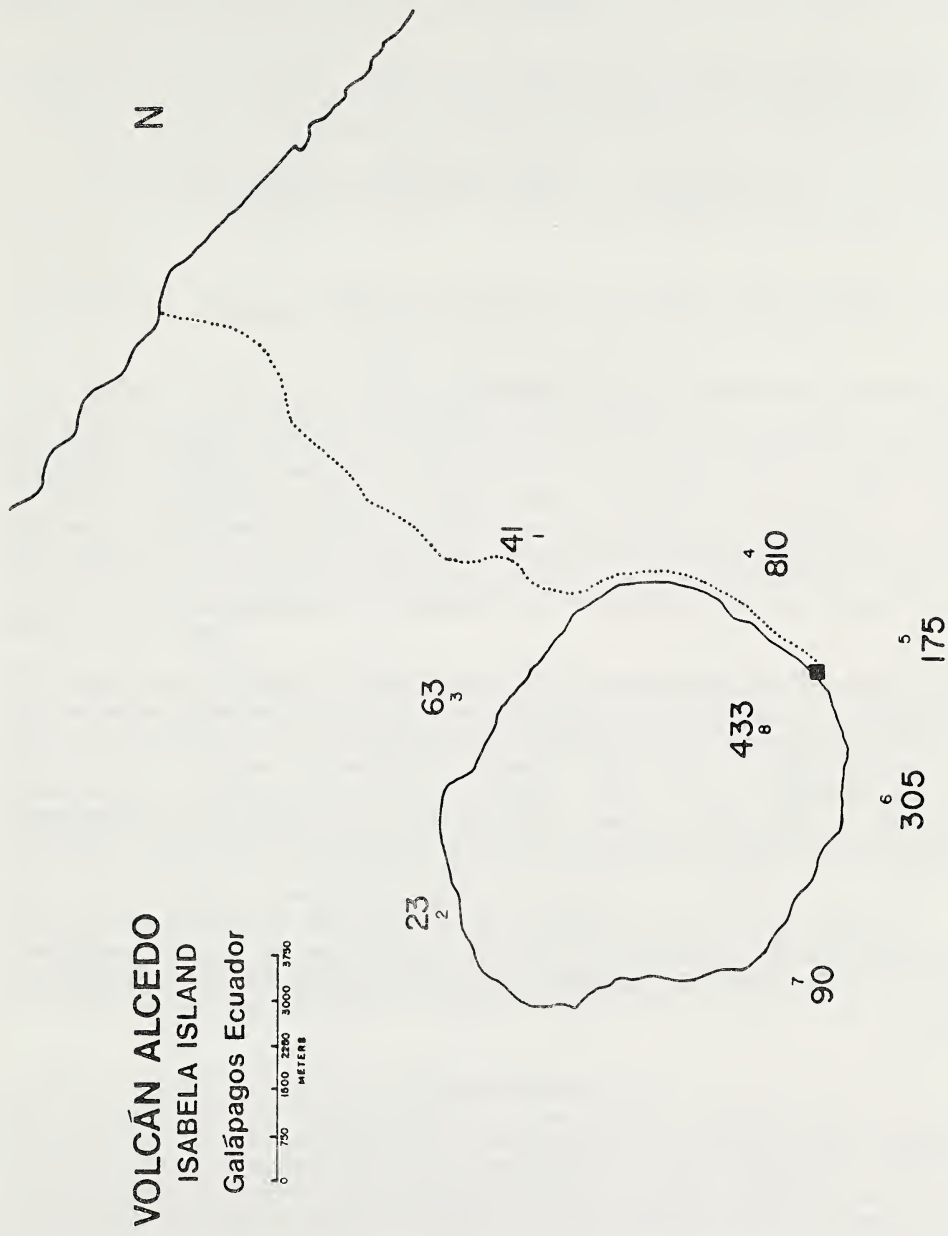


Figure 3. Map showing the total distribution of tortoises during the study.

Discussion

Individual tortoise movements appear to be localized within specific areas, although long range movement may also occur. Tortoise activity begins in the early morning during which time most of the foraging behavior takes place. The Alcedo tortoises are considered to be grazers feeding on grasses and other low lying vegetation (Fowler and Johnson, 1985). Because the availability of vegetation is positively correlated with the amount of moisture in an area, population shifts are therefore dependent on the prevailing weather patterns (Table 2).

Table 2. Summary data showing the relationship between climatic conditions/vegetation patterns to tortoise population location.

SECTION	CLIMATE	TEMPERATURE °C	HUMIDITY	VEGETATION	TORTOISE #
4,5,6	Wet	18.7/17.5	92.5	Dense/Closed	1,290
1,7,3	Temperate	20.1/18.2	85.2	Intermediate	194
2	Dry	24.4/19.1	66.2	Sparse/Open	23**
8					433**

*Although both of these areas are dry, Section 8 is located on the southeast part of the volcano floor and inner slopes. This area receives more moisture and supports a greater amount of vegetation.

Note: Dense/Sparse - % of cover, amount of vegetation, etc.

Closed/Open - herb layer

See Wiggins and Porter, 1971 and Hamann, 1981 for more detail regarding the vegetation and plant communities.

The majority of marked tortoises remained in or around the area where they had been marked (Section 4). These relatively small movement patterns (50-400 m) suggest that the tortoises have a preference for the southeast section of the volcano due to higher moisture levels and more pervasive vegetation.

Of the marked tortoises relocated during the December and June trips, a slightly larger number of males were relocated compared with females. This may suggest that males are more sedentary while females, due to their nesting capabilities, may move over a much larger range. Also, males are more readily observed while females, due to their smaller size, are difficult to locate in the surrounding vegetation. Further study may help to reinforce these hypotheses.

Table 3. Summary data of marked male and female tortoises relocated after the initial marking.

SEX	NUMBER OF TORTOISES RECOVERED			TOTAL
	<u>Sept. 1983</u>	<u>Dec. 1983</u>	<u>June 1984</u>	
Male	8	5	5	18
Female	9	4	1	14

Further evidence of tortoise movement can be observed in the daily movement patterns of tortoises between other areas of the crater and the rim. Continuous movement over a period of years had produced "tortoise trails" in these areas of heavy use (e.g., rim, outer slopes, and floor). This movement increases dramatically during the wet season. Depressions along the rim fill with water and heavy tortoise activity is observed during this time. Large dry areas on the floor and around the geyser area suggest that these areas fill with water during the wet season as well, and attract large numbers of tortoises (Moore, 1980). As these pools dry up the tortoises begin to move out to other areas.

During the recent El Niño (1983-1984) record levels of rainfall were observed throughout the islands, resulting in an abundance of vegetation. Tortoise movements during this time were extensive; evidence shows that the populations on Santa Cruz and Alcedo ranged over a much larger area when compared with previous years (Cayot, 1983). On Alcedo, tortoises were seen as far west as the coast, just up from the beach (De Roy, 1984). Movements along the outer slopes increased, producing a maze of trails through the vegetation. This widespread movement is directly related to the increased amount of available food, allowing the tortoises to forage over a much larger area. We can conclude that population movement, both localized and widespread, does occur on Volcán Alcedo. These movement patterns are dependent on seasonal weather patterns, especially rainfall, which determines the amount of vegetation that is available for food.

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A RELIC POPULATION OF THE "BEJUQUILLA VERDE,"
Oxybelis fulgidus, IN SOUTHERN
VERACRUZ, MEXICO (REPTILIA: SERPENTES)

Abstract

An isolated population of *Oxybelis fulgidus* in the Los Tuxtlas highlands is reported, extending the range of the species on Atlantic slopes westward from eastern Campeche and El Petén, Guatemala, to trans-Isthmian, southern Veracruz.

Although *Oxybelis fulgidus* has an unusually extensive range, Mexico to Argentina, its distribution in México is surprisingly limited. On Pacific slopes it is limited to Chiapas and the Isthmus of Tehuantepec region of Oaxaca, whereas on Atlantic slopes it has been recorded only from the central and eastern parts of the Yucatán peninsula, including localities in the states of Yucatán, Quintana Roo and eastern Campeche. The species is known from numerous records in Guatemala, Belize and southward in tropical America (see Lee, 1980:69, for a spot map showing distribution in the Yucatán peninsula and its base). No records exist for Atlantic slope regions west of northeastern Campeche, except for two highly dubious reports for Tamaulipas: one in Velasco (1892:209) for "Tamaulipas," and another in Crimmins (1937:233), for Horsetail Falls, 35 km S Monterrey, Coahuila. The latter almost certainly is a misidentification of *Oxybelis aeneus*, which is well known to occur in that region (e.g., Martin, 1958:71), and the Velasco report is seemingly just a guess (*Oxybelis aeneus* is also listed for Tamaulipas in the same report).

However, a previously unrecorded, isolated and presumably relic population exists in southern Veracruz, as documented by Univ. Michigan Mus. Zool. 113766 from 2 mi S Catemaco; a specimen in the Southwest Missouri State Univ. collection from near Catemaco (courtesy Dr. Don Moll, pers. comm.); and an adult male taken by one of us (GPH), October, 1979, in a moist forest area near Playa Azul, Municipality of Catemaco, Veracruz, 360 m (UNAM-LT 410 in the collection of the Estación de Biología Tropical Los Tuxtlas).

The latter specimen, the only one of the three that we have examined, conforms in most respects with descriptions of the species elsewhere (e.g., Wilson and Meyer, 1985:79): nasal single; no loreal; prefrontal in contact with three supralabials; preocular single; 2-2 postoculars; 10-10 supralabials, 5th, 6th and 7th entering orbit; 10-10 infralabials; 194 ventrals (extending the previously recorded range of 198-217); 145 subcaudals; 17-17-13 dorsal scale rows; only three middorsal scale rows keeled on posterior half of body.

Color and pattern in life typical, green above and below, lighter ventrally; a yellowish-white line on each side of venter, exclusively along edges of ventrals. Unlike the Chiapas material described by Alvarez del Toro (1982:175), there is no yellow on the labials.

The presence of this species, isolated by some 500 km from the nearest recorded Atlantic slope population, and about 200 km from the nearest Pacific slope records, adds another to the distinctive fauna of the Catemacan Biotic District (e.g., Pérez-Higareda and Vogt, 1985:141).

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HERPETOLOGY OF PRESQUE ISLE STATE PARK
ERIE, PENNSYLVANIA

The purpose of this report is to add data from unpublished studies (McPherson, 1982) and field notes (McAllister, 1986) to that which has been previously published (Hudson, 1930; McKinstry and Felege, 1974; McKinstry, 1975; McCoy, 1982) thus providing an up-to-date summary of the occurrence of reptiles and amphibians on Presque Isle State Park, Erie, Pennsylvania. The impetus for this report comes from recent interest in the natural areas of the Park and subsequent establishment, through local and State efforts, of committees to prepare resource management plans.

Presque Isle State Park consists of a 3,100 acre peninsula which arises from the south shore of Lake Erie in northwestern Pennsylvania. A variety of habitats including sandy beaches, grassy plains, swamps, ponds, lagoons, and woodlands are present.

The distribution of reptiles and amphibians of the Park has been studied sporadically, however, definitive long-term studies employing modern sampling methods are lacking. As a starting point for such studies, this report lists the species occurring (or known to have occurred) in the Park as follows: salamanders, four species (Table 1); frogs and toads, nine species (Table 2); turtles, nine species (Table 3); snakes, eight species (Table 4). Two species of special concern and one species of possible concern are listed with additional information in Table 5. For each species listed, a brief account of its status in the Park is given. Species not indigenous to northwestern Pennsylvania but which have been observed in the Park are not included but rather are noted here as follows: ornate box turtle, *Terrapene ornata ornata* (probably identification); red-eared turtle, *Chrysemys scripta elegans*; spectacled caiman, *Caiman crocodilus*. These specimens probably represent released pets.

In planning future studies on the reptiles and amphibians of the Park, one should consult McPherson's report (1982), available in the Park Office, as it gives a framework for such studies. Reptiles and amphibians are important members of the Park ecosystem and should be conserved. Populations of these animals are highly sensitive to changes involving temperature, water level, water quality, and vegetation. Accurate, complete, and up-to-date baseline data on these populations could help to evaluate such changes.

Table 1. Salamanders observed on Presque Isle
State Park, Erie, PA

<u>Species</u>	<u>Reference (a)</u>
*mudpuppy <i>Necturus m. maculosus</i> observed in the Bay and in the larger lagoons, not uncommon	1, 4, 7
*spotted salamander <i>Ambystoma maculatum</i> found in the Cranberry Pond area (hardwood forest with sandy ridges and shallow swamps), only observed in one survey	4, 5
red-spotted newt <i>Notophthalmus v. viridescens</i> common in a variety of habitats	1, 2, 4, 5, 7
*northern spring salamander <i>Gyrinophilus p. porphyriticus</i> record based on specimen collected in 1906, occurrence in the Park at present is questioned	4

(a) - Refer to Literature Cited.

*The status of these species appears uncertain; i.e., have not been generally noted in most surveys, have not been observed recently, or have limited distribution in the Park. Thus, the occurrence and distribution of these species should have priority in future studies of the Park's herpetofauna.

Table 2. Frogs and toads observed on Presque
Isle State Park, Erie, PA

<u>Species</u>	<u>Reference</u>
eastern American toad <i>Bufo a. americanus</i> common throughout the Park	1, 3, 4, 7
Fowler's toad <i>Bufo woodhousei fowleri</i> quite abundant particularly along sandy ridges near the beaches	1, 3, 4, 7
northern spring peeper <i>Hyla c. crucifer</i> choruses heard during the spring in many areas	1, 3, 4
*gray treefrog <i>Hyla versicolor</i> choruses heard during the spring in areas toward the tip of the peninsula	3, 7
*bullfrog <i>Rana catesbeiana</i> observed or heard in small lagoons near tip of peninsula	3, 7
green frog <i>Rana clamitans melanota</i> abundant in many areas containing lagoons and small inland ponds	1, 2, 3, 4, 7
*pickerel frog <i>Rana palustris</i> status unknown	4
northern leopard frog <i>Rana pipiens</i> abundant in moist habitats	1, 2, 3, 4, 7
*wood frog <i>Rana sylvatica</i> common on the Bird Sanctuary, status elsewhere in the Park not known	1, 4, 7

Table 3. Turtles observed on Presque Isle
State Park, Erie, PA

<u>Species</u>	<u>Reference</u>
common snapping turtle <i>Chelydra s. serpentina</i> abundant, found in lagoons and inland ponds	1, 3, 4, 7
stinkpot <i>Sternotherus odoratus</i> found in shallow ponds and lagoons, evidence of mammal predation on nests observed	1, 3, 4, 7
*spotted turtle <i>Clemmys guttata</i> has been observed on the peninsula but present status is unknown	1, 4
*wood turtle <i>Clemmys insculpta</i> has been observed on the peninsula but present status is unknown	1, 4
*Blanding's turtle <i>Emydoidea blandingi</i> one specimen recently observed near the Maintenance area (a hardwood forest region), status of this species at present is not known	3
*eastern box turtle <i>Terrapene c. carolina</i> no recent records of its occurrence, status at present unknown	1, 4
map turtle <i>Graptemys geographica</i> observed in several localities, most numerous in Horseshoe Pond and Misery Bay areas	1, 3, 4, 5, 7
midland painted turtle <i>Chrysemys picta marginata</i> the most abundant turtle on the peninsula, regularly found in shallow lagoons and inland pond areas	1, 3, 4, 5, 7
*eastern spiny softshell <i>Trionyx s. spiniferus</i> observed in several areas including Horseshoe Pond, status unknown	1, 3, 4, 7

Table 4. Snakes observed on Presque Isle
State Park, Erie, PA

<u>Species</u>	<u>Reference</u>
*queen snake <i>Regina septemvittata</i> has been observed in vegetation growing over water, present status unknown	1, 3, 4, 7
*northern water snake <i>Nerodia s. sipedon</i> has been observed in the Park but at present may not be particularly abundant	1, 4, 7
northern brown snake <i>Storeria d. dekayi</i> second in abundance to the eastern garter snake, most common in open areas	1, 3, 4, 5, 6, 7
*shortheaded garter snake <i>Thamnophis brachystoma</i> only one record exists for the Park, an introduced individual?	1, 4
*eastern ribbon snake <i>Thamnophis s. sauritus</i> (a) occasionally observed	1, 3, 4, 6
eastern garter snake <i>Thamnophis s. sirtalis</i> present in many areas, the most visible snake species in the Park	1, 3, 4, 5, 6, 7
*eastern hognose snake <i>Heterodon platyrhinos</i> has not been observed in recent years, present status is unknown	1, 4, 8
*eastern milk snake <i>Lampropeltis t. triangulum</i> no recent records, present status is unknown	1, 4

(a) Listed as the northern ribbon snake, *Thamnophis s. septentrionalis* (5)

Table 5. Amphibians and reptiles of Presque Isle State Park, Erie, PA: Species of Special Concern (a) (or possible special concern) in Pennsylvania.

<u>Species</u>	<u>Habitat</u>	<u>Comment</u>
Blanding's turtle <i>Emydoidea blandingi</i>	wetlands (4)	"recent extirpated?" (4)
queen snake <i>Regina septemvittata</i>	areas containing crayfish (4)	"populations...should be carefully monitored, to determine whether it is a candidate for listing as a species of special concern (4)
eastern hognose snake <i>Heterodon platyrhinos</i>	areas with sandy soil (4)	"status undetermined" (4)

(a) From reference (4) McCoy 1982: "Status.-The status category adopted by the Committee on Amphibians and Reptiles of Special Concern, Pennsylvania Biological Survey (1981) is given for each species. Species not assigned to a special concern category by the Committee are identified by the statement "not listed." For the listed species five categories are recognized and defined as follows: Endangered - species in imminent danger of extirpation throughout their range in Pennsylvania if factors affecting them continue to operate. Threatened - species for which the available evidence indicates that they may become endangered or extirpated throughout their range in Pennsylvania within the foreseeable future. Vulnerable - species which are potentially at risk because: a) they exist only in restricted geographic areas or habitats, b) their population density is low, or c) they or their habitat are particularly susceptible to exploitation. Status Undetermined - species suspected of falling into one of the above categories, but for which available data are not adequate to make a status decision. Recently Extirpated - species that have disappeared from Pennsylvania since 1600."

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DISTRIBUTION RECORDS OF *Graptemys*
IN OKLAHOMA

The semi-aquatic turtle genus *Graptemys* is represented by members of three species in Oklahoma. The Mississippi Map Turtle, *Graptemys kohni* (Baur), is found in the Arkansas and Red River systems in the eastern-third of the state; the Map Turtle, *Graptemys geographica* (Le Sueur), is known only from specimens collected in 1927 in Delaware County (Ortenburger, 1929); and the Ouachita Map Turtle, *Graptemys pseudogeographica ouachitensis* Cagle, occurs throughout the eastern two-thirds of the state associated with the Arkansas and Red River systems. Smith and Brodie (1982) list *G. p. ouachitensis* as the species, *G. ouachitensis*, and *G. kohni* as the subspecies, *G. p. kohni*. Webb (1970) notes the relatively few specimens of this genus available for study from Oklahoma.

From 1981 through 1985, Pigg conducted a study of rivers and lakes throughout Oklahoma as part of the Biological Monitoring Program of the Oklahoma Health Department. Specimens were collected either (a) in gill nets set across rivers and lakes for two hour periods, or (b) by hand-seining rivers and lakes (20 seine hauls of 10 meters each were conducted at each sampling site). Turtles were removed from nets, preserved and deposited in the Bailey Science Museum at Oklahoma Baptist University.

In the fall of 1986, Lardie deposited at the Museum at sizeable collection of reptiles and amphibians obtained in northwestern Oklahoma from 1971 to 1986. This collection contains a number of distribution and observation records.

G. kohni was collected in only three Oklahoma counties (Table I) indicating the apparent scarcity of this turtle in the state. The specimen (OBU 272-86) from Lake Raymond Gary, Choctaw County, is a county record and extends the range westward along the Red River for members of this species in Oklahoma. Additional collecting will probably extend the range of the Mississippi Map Turtle farther westward along both the Red and Arkansas River systems. Collins (1982) reports that this turtle occupies soft-bottomed and vegetated rivers, lakes and sloughs in Kansas.

Even though Webb (1970) reports he examined a specimen of *G. kohni* from Cherokee County in the Tulane University collection, Secor and Carpenter (1984) indicate only a sight (DOKARRS) record in that county for the Mississippi Map Turtle. The specimen (OBU 274-86) collected by Pigg in Tenkiller Reservoir, Cherokee County, confirms the occurrence of *G. kohni* in the county.

Webb (1970) and Secor and Carpenter (1984) show *G. p. ouachitensis* associated with the Red and Arkansas River systems in Oklahoma. Its range extends westward along these rivers and their tributaries into the oak-woodland forests and grasslands of central and western Oklahoma. Ouachita Map Turtles prefer waters with an abundance of aquatic vegetation. Five county records are represented in the Pigg Collection from Sequoyah, Delaware, Tulsa, Atoka and Pushmataha Counties (Table I).

Table I. Oklahoma collection records of *Graptemys kohni* and *Graptemys pseudogeographica* in the Pigg Collection (1981-1985) and the Lardie Collection (1971-1986). Both collections are presently in the Bailey Science Museum, Oklahoma Baptist University, Shawnee, Oklahoma

SPECIES	LOCALITY	COUNTY	NUMBER OF SPECIMENS	OBV MUSEUM NO.
<i>G. kohni</i>	Lake Raymond Gary near Ft. Townsend**	Choctaw Co.	5	273-86
	Tenkiller Reservoir***	Cherokee Co.	2	274-86
	Verdigris River, Rocky Point Park	Rogers Co.	1	275-86
<i>G. p. ouachitensis</i>	Robert S. Kerr Reservoir**	Sequoyah Co.	1	276-86
	Grand Lake**	Delaware Co.	2	277-86
	Arkansas River north of Bixby**	Tulsa Co.	1	286-86
	Muddy Boggy north of Lane**	Atoka Co.	1	288-86
	Kiamichi River south of Clayton**	Pushmataha Co.	1	282-86
	State Line bridge on Chikaskia River***	Grant Co.	1	289-86
	Skeleton Creek west of Douglas****	Garfield Co.	1	DOKARRS
	Red River south of Terra	Jefferson Co.	4	278-86
	Red River southwest of Waurika	Jefferson Co.	1	279-86
	Red River south of Harbils	McCurain Co.	4	280-86
	Pine Creek Reservoir, Little River State Park	McCurain Co.	1	283-86
	Little River south of Idabel	McCurain Co.	1	286-86
	Washita River north of Dickson	Carter Co.	1	281-86
	Verdigris River, Rocky Point Park	Rogers Co.	1	284-86
	Kaw Reservoir east of Newkirk	Kay Co.	1	285-86
	Chikaskia River south of Blackwell	Kay Co.	1	287-86
	Red River south of Hugo	Choctaw Co.	1	290-86

**New county record

***Museum voucher that verifies previous sight (DOKARRS) record(s) as summarized in Secor and Carpenter (1984).

****Sight (DOKARRS) record for county

There is a scarcity of records for *Graptemys* from counties in northeastern Oklahoma (Webb, 1970; Secor and Carpenter, 1984) and from adjacent counties in Kansas (Collins, 1982). This area, in part, includes the Ozark Plateau, which is one of the most rugged and wooded terrains in Oklahoma. Streams are characteristically clear and bedded with coarse sediment. Perhaps the clear, coarse-bedded streams of the Ozark Plateau in Oklahoma do not provide suitable habitats for *Graptemys*. This is an area in Oklahoma deserving of study.

The Lardie Collection contains an observation record of the Ouachita Map Turtle in Garfield County. This observation represents the first recorded sighting for this turtle in Garfield County. The Lardie Collection also contains a specimen (OBU 289-86) which verifies the sight (DOKARRS) record for Grant County (Secor and Carpenter, 1984), and the literature reports of Lardie (1980, 1982) and Lardie and Black (1981).

The range westward of this turtle genus (*Graptemys*) is probably determined by permanency of water in western Oklahoma (Webb, 1970). Lardie (pers. comm.) suggests that map turtles have reached the Chikaskia River on the Oklahoma-Kansas border in northwestern Oklahoma via the Salt Fork branch of the Arkansas River.

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COMMENTS ON THE SNAKE GENERIC NAMES

Antaresia and *Australiasis*

Wells and Wellington (1983) in an unprecedented taxonomic upheaval (involving at least 79 taxonomic changes in snakes alone) of Australian reptilian taxonomy described two new bold genera. Even if the newly created generic levels are justified, here doubted, nomenclatural errors are involved.

First, the genus *Antaresia* was created to include the species *childreni* Gray, 1842, *gilberti* Gray, 1842 (designated as type), *maculosus* Peters, 1843, and *perthensis* Stull, 1933. The most common allocation of these species has been to include them in the genus *Liasis* (e.g., McDowell, 1975, Smith, 1981 and 1985). An exception to that is Cogger, et al., 1983, who placed *Liasis* in the genus *Bothrochilus*, and who did not explain why *Liasis* Gray, 1842 was selected over *Bothrochilus* Fitzinger, 1843. McDowell, 1975, placed the then monotypic *Bothrochilus* *boa* in the genus *Liasis*.

If one assumes that these four species are deserving of separate generic recognition, then the name *Liasis* Gray, 1842 would be the appropriate name. McDowell (1975) pointed out that no type was designated for *Liasis*. McDowell (pers. comm.) indicated that Desmarest (1845: 337) designated a type species (*Boa amethystina* Schneider) for *Liasis*. Stimson and McDowell in an application (manuscript) to the International Commission on Zoological Nomenclature indicated that acceptance of this would be unwise based on: (1) the past instability of the generic placement of *amethystinus* (i.e., variously placed with *Python*, *Morelia*, and *Liasis*), (2) that now and possibly in the future it could cause numerous otherwise unnecessary nomenclatorial changes, and that, (3) it appears likely that Gray's reference to *Boa amethystina* (sic) was not based on an actual specimen of *Liasis mackloti*. Stimson and McDowell in their application ask the ICZN to set aside the Desmarest (1845) restriction and to name *L. mackloti* as type of *Liasis*. Gray (1849) divided *Liasis* into three subgenera with the subgenus *Liasis* being monotypic for *L. childreni*, thus indirectly designating a type for that species, if one considers Desmarest (1845) as undesirable. If one follows McDowell (1975) and/or Smith (1981, 1985) interpretation of the genus *Liasis* it really does not matter whether the type is designated as *childreni* or *mackloti*.

Before discussing the group further, it is necessary to point out Wells and Wellington's (1983) recognition of *Lisalia* Gray (for the species *albertisi* Peters and Doria, 1878), *barroni* Smith, 1981, *fuscus* Peters, 1873, and *olivaceus* Gray, 1842, all previously included in *Liasis*) would be correct from the standpoint of the Rules, as *olivaceus* is the type species of *Lisalia*.

This leaves *boa* Schlegel, 1837, *maximus* Werner, 1936, and *papuanus* Peters and Doria, 1878, species formerly in *Liasis*, without a name. If one wishes to follow a subdivision as presented by Wells and Wellington (I do not), *Bothrochilus* Fitzinger, 1843 (type species *Tortrix boa* Schlegel), would

be the next available name. It would seem preferable to follow McDowell (1975) and Smith (1981, 1985) at least until more detailed work indicates differently.

Another problem (of many) created by Wells and Wellington is their description of the new bold genus *Australiasis* (type species: *Boa amethystina* Schneider 1801). They include *kinghorni* Stull, 1933 and *oenpelliensis* Gow, 1977, as well as *amethystina*, in this taxon. McDowell (1975), in his synonymies, included two generic names which would be available for *amethystinus* if one wished to take it out of *Python* or *Liasis*. The name *Simalia* Gray, 1849, by restriction of the type species, could be available. It was originally used as a subgenus containing both *amethystinus* and *mackloti*; no type was designated. In addition the name *Aspidopython* was erected by Meyer (1875) for *A. jakati* (which is a junior synonym of *amethystinus*) and is available if necessary for separating the above species.

The generic name *Australiasis*, then, if McDowell (1975) is followed, is a junior synonym of *Python*; or, if one wishes to recognize that group as distinct (i.e., follow Wells and Wellington), then *Australiasis* is a junior synonym of either *Simalia* or *Aspidopython*.

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A TWO-HEADED SNAKE, *Bothrops asper*, FROM
SOUTHERN VERACRUZ, MEXICO

Although hundreds of bicephalous snakes have been recorded in the literature, they are still rarities, calculated as occurring in a proportion of one in 100,000 neonates (Belluomini et al., 1978:117). The anomaly has been recorded in at least 110 species and subspecies, representing most families and both oviparous and viviparous species. Only four species of *Bothrops* (sensu lato) are represented: *B. alternata* (Berst, 1945; Prado, 1946); *B. atrox* (as summarized in Cunningham, 1937:90); *B. jararaca* (Pereira, 1950); and *B. jararacussu* (Pereira, 1944). We here add another species of that genus, *B. asper* (Garman).

The specimen (UNAM-LT 3117 from Balzapote, Municipality of San Andrés Tuxtla, Veracruz, in the herpetological collection of the Los Tuxtlas UNAM Estación de Biología Tropical) is a full-term embryo among 63 otherwise normal ones extracted from a dead female. All had expired through long exposure to the sun. The two-headed specimen, 170 mm in total length (tail 24 mm), exhibits no other abnormalities; scutellation and pattern are normal. The head and neck are paired for a length of 20 mm.

We are grateful to Sr. Javier Ramírez Torres, of the Los Tuxtlas Station, for the discovery and donation of the material.

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ENCAPSULATION, TRANSLOCATION AND HATCHING SUCCESS OF
Ambystoma tigrinum tigrinum (GREEN) EGG MASSES

Abstract

The effect of water quality on the hatching success of Eastern tiger salamander, *Ambystoma tigrinum tigrinum* (Green) egg masses was investigated to determine if water quality influenced the reduction in the number of *tigrinum* breeding ponds in Maryland. *Tigrinum* egg masses were translocated from an active breeding pond to a previously active pond. Hatching successes of the egg masses were compared. Dissolved oxygen (DO) and pH measurements were taken at both sites. It was determined that water quality, specifically DO and pH, does not effect hatching success for the egg masses. It was also determined that *tigrinum* egg masses can be translocated easily and *tigrinum* larvae can adapt to survive in their new environment through alteration of body coloring and gill size.

Introduction

The Eastern tiger salamander, *Ambystoma tigrinum tigrinum* (Green) in the adult form is burrowing and nocturnal and may be found in temporary ponds during breeding season. Stine (1979) states that various types of breeding ponds may be selected by the *tigrinum* and that specifying a single type of breeding pond using a few limiting factors is difficult. *Tigrinum* eggs have been and are still deposited in ponds that vary in stages of succession.

When ponds fill or thaw, adult *tigrinum* return to the breeding pond they left the previous year. Adult *tigrinum* may return to Maryland ponds from late November through March, (Stine, 1984) beginning during a period of warmer temperatures and usually after a rainfall or snow/ice melt. (Hassinger, 1970) Water temperature does not seem to be critical. (Stine, 1977) After breeding, adults once again leave the ponds. (Bishop, 1941) The incubation period for eggs in Maryland is 29-33 days. However, if colder temperatures prevail, the incubation period may be prolonged. (Anderson, et al., 1971 and Lee, 1973) Evidence indicates that climatic factors, particularly temperature, have a direct influence on egg deposition, hatching, and metamorphosis. (Bishop, 1941 and Hassinger, 1970) Once the eggs hatch, the larvae develop quickly and become voracious, opportunistic feeders. (Lee, 1974) The larvae leave the pond after transforming to juveniles in late June. (Stine, 1977, 1984)

As a result of the presumed decreasing population of the tiger salamander within the state of Maryland, the salamander has been placed on Maryland's endangered species list. (Stine, 1984) Major breeding populations are limited primarily to one pond in Kent County (Massey) and one in Caroline County. Limited egg deposition and larval density have been observed in other ponds in Kent County and in Caroline County, but egg masses found there have high mortalities.

Lee and Franz (1974) describe Massey Pond as approximately one acre, seasonally related. Half of the pond is surrounded by a road and cultivated farmland while secondary deciduous forest fringe the remaining periphery.

Although areas of Massey Pond have dense aquatic vegetation, the central, deepest section where concentrated egg deposition occurs is sparsely vegetated. Stine (1979) notes that Massey, with its open canopy, is going through successional changes, although not along typical lines, due to maintenance of the adjacent terrestrial plant community and removal of some predators. According to local residents, Massey Pond was dry the entire year of 1981. When Massey was examined January 13, 1982, it still contained no water. However, by February 2, 1982, water had begun filling the pond. The ephemeral condition of Massey was also noted in the summers of 1984 and 1986 when the pond became dry in August.

Golts Pond, not as seasonal as Massey, is smaller and deeper in the center. It has a closed canopy and is filled with vegetation. Succession is more advanced being closer to climatic climax. Although Golts Pond was once an active breeding site, egg masses have not been observed there since ca. 1977. Golts Pond has not demonstrated its ability to support a population of tiger salamanders in recent years.

In an attempt to determine factors influencing the reduction of the number of breeding ponds, the effect of water quality on the hatching success of *tigrinum* egg masses was investigated. The initial assumption was that a parameter(s) of water quality had changed significantly over the years in Golts Pond so that a previously active breeding pond could no longer support the development of the egg masses to the larval stage. The question posed was, does the quality of pond water have an effect on the hatching of *tigrinum* eggs and/or development of larvae?

The approach used for this study was to translocate egg masses from an active breeding pond to a previously active pond to compare the hatching success between the two ponds. Dissolved oxygen (DO) and pH measurements were taken at both sites to determine what effects these physical parameters would have on the survival of the egg masses.

Materials and Methods

To determine if pond succession had an effect on eggs of the tiger salamander, egg masses were encapsulated and translocated from Massey to Golts Pond. In the spring of 1982, egg masses were selected, encapsulated, and secured. The capsule consisted of a two-liter plastic soda bottle cut at both ends with additional windows cut in the center. The windows allowed water circulation. These light weight plastic structures were placed inside a single cylindrical piece of panty hose cut from the leg area of the hose. (Figure 1) The nylon mesh was tied at one end, and the egg mass was inserted. The remaining end was tied, and the entire capsule was secured to a wooden stake driven into the pond substrate so that the egg mass was situated at approximately the same level in the water from which it was taken. (Figure 2).

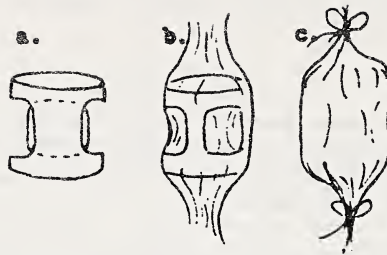


Figure 1. Egg mass encapsulations: a) Light-weight plastic structure; b) Single cylindrical piece of panty hose covering plastic; c) Nylon mesh tied at both ends.

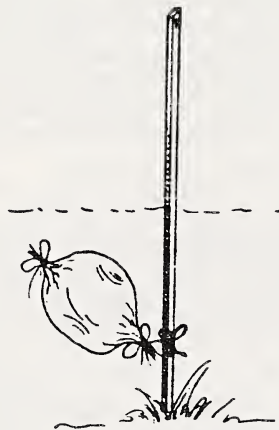


Figure 2. Egg mass encapsulation secured to a wooden stake below the surface of the pond.

Three egg masses were encapsulated at Massey on February 24, 1982, and left there. On February 27, 1982, an additional five egg masses encapsulated at Massey were translocated in large buckets of Massey Pond water to Golts Pond. Three of the egg masses were placed in Golts Pond at the same depth as originally located at Massey. Two of the egg masses were returned to Massey Pond and staked in the position from which they were originally taken. These two masses were used as a control to identify any effects of transportation

movement and handling of the masses. Encapsulated egg masses were checked periodically to determine mortality and proximity to hatching. Upon hatching, the larvae were released from the capsules.

The dissolved oxygen content was taken at Massey and Golts using a YSI dissolved oxygen meter. A LaMotte pH meter was used to obtain pH readings. The pH meter was calibrated using buffered solutions that encompassed the range of the readings.

Results

Egg mass encapsulations were opened on hatching and larvae released. Both the living and dead larvae from the egg masses encapsulated at Massey and Golts were counted. Table 1 shows the location, number of eggs encapsulated, and the mortality of the enclosed eggs. Of a total of 522 living eggs encapsulated, 491 living larvae were released for an average survival success of 94% in both ponds. The egg masses encapsulated at Golts (6,7, and 8) resulted in 100% survival success. Excluding capsule no. 3, the overall survival success at Massey Pond was 97% for encapsulations 1,2,4, and 5. The hatching success for encapsulations no. 1 and 2 was 98.4% while the control encapsulations (4 and 5) had a hatching success of 95.2%. Encapsulation no. 3 had an anomalously low survival success of 19.2%.

TABLE 1: EGG ENCAPSULATIONS

EGG ENCAPSULATION NUMBER	DATE ENCAPSULATED	LOCATION OF ENCAPSULATION	DEPTH OF EGG MASS (cm)	NUMBER OF EGGS LIVING WHEN ENCAPSULATED	NUMBER OF EGGS DEAD WHEN ENCAPSULATED	DATE OF RELEASE	NUMBER OF LARVAE ALIVE WHEN RELEASED	NUMBER OF LARVAE DEAD WHEN RELEASED
1	2/24/82	Massey	37	144	0	3/21/82	142	2
2	2/24/82	Massey	35.5	42	3	3/21/82	41	4
3	2/24/82	Massey	43	26	7	3/21/82	5	est. 18 ⁺⁺
4*	2/27/82	Massey	47	72	1	3/21/82	68	5
5*	2/27/82	Massey	43	75	2	3/21/82	72	5
6	2/27/82	Golts	47	29	0	3/25/82	29	0
7	2/27/82	Golts	42	47	0	3/25/82	47	0
8	2/27/82	Golts	39	87	0	3/25/82	87	0

*Control transported to Golts from Massey and back to Massey.

++Accurate count of living and dead larvae impossible.

Egg encapsulation no. 3 had seven dead eggs, and green algae (*Chlamydomonas*) had penetrated the egg mass at the onset of enclosure. When the larvae were released, algae in the egg mass was so diffuse that the number of eggs or larvae encapsulated could not be distinguished.

On examination, the larvae from Massey and Golts Ponds exhibited distinct differences. The larvae at Golts were darker in color than those observed at Massey. Golts larvae color matched the darker leafy bottom of Golts Pond, whereas the Massey larvae were lighter in color and blended well with the light-colored substrate. Also, the gills were appreciably larger on the Golts larvae than those of comparable size from Massey.

The dissolved oxygen content at both Massey and Golts is shown in Table 2. The dissolved oxygen content was consistently higher at Massey than Golts. Although on March 6, 1982, Golts and Massey Ponds had comparable dissolved oxygen contents, the difference in dissolved oxygen between the two ponds increased during the study period. While the DO content at both ponds was observed to decrease, the DO at Golts decreased significantly more. On June 11, 1982, Massey's DO content was 6.6 ppm whereas Golts' was considerably lower at 0.6 ppm. It is during this spring period that larvae are developing most rapidly.

The pH data for Massey and Golts are presented in Table 3. These data indicate that Massey had a consistently lower pH than Golts. Massey's pH on March 6, 1982, was 3.6 compared to 5.8 for Golts. The pH at Massey rose slightly from 3.6 to 4.5 during the course of the study with a drop on June 11, 1982. The pH at Golts was relatively stable during the same time period.

Discussion

Results of hatching success of egg masses of the tiger salamander encapsulated and retained at Massey were compared with those encapsulated and translocated to Golts as well as those transported and returned to Massey. The two egg masses that were encapsulated, transported and returned to Massey Pond were used as a control to identify any effects of translocation and handling of these masses. These controls were initiated although Anderson (1971) reported that those eggs handled once or more than once showed no mortality difference.

It is interesting to note that the eggs encapsulated and placed in Golts Pond resulted in 100% survival success. When encapsulation no. 3 is excluded from consideration, the eggs encapsulated and left at Massey resulted in an overall survival success of 97%. It is difficult to believe that the 98.4% survival success for encapsulations nos. 1 and 2 is significantly different from the 95.2% survival success for the control encapsulations nos. 4 and 5. Consequently, it is concluded that translocation of egg masses between Massey and Golts Ponds has little or no effect on the survival success.

TABLE 2: DISSOLVED OXYGEN (ppm)

DATE	MASSEY		GOLTS	
	SURFACE	BOTTOM	SURFACE	BOTTOM
3/6/82	11.8	11.75	11.2	11.0
3/13/82	10.4	9.8	NA	NA
4/30/82	10.5	NA	NA	NA
6/11/82	6.6	NA	.6	NA
7/15/82	8.2	8.0	3.6	.45

NA = Not available

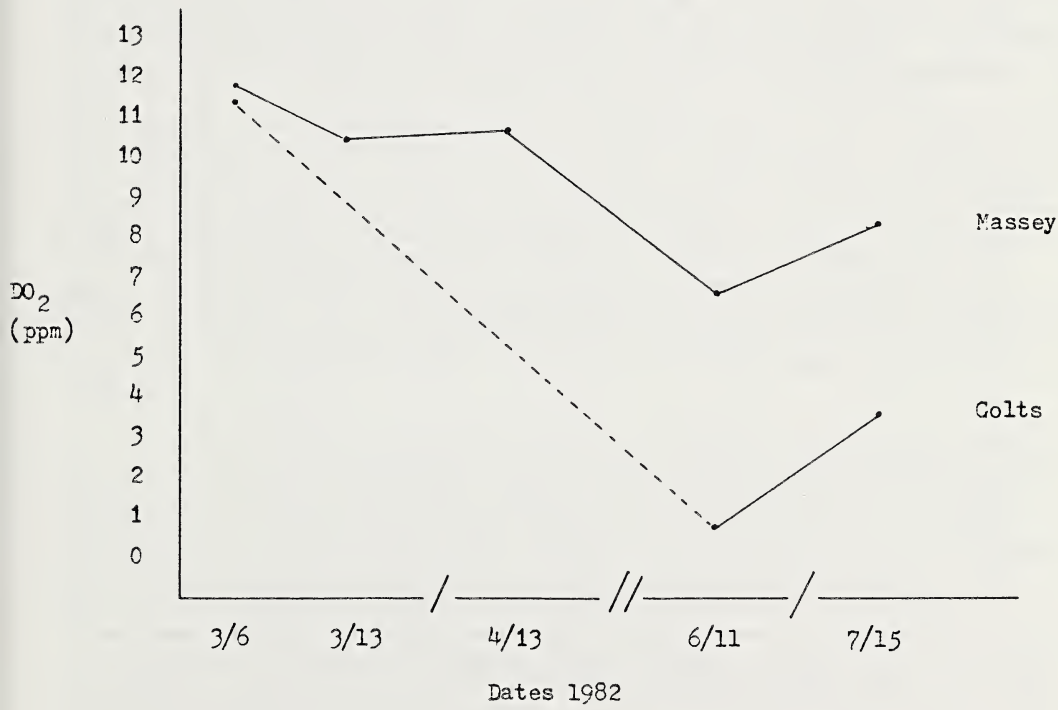
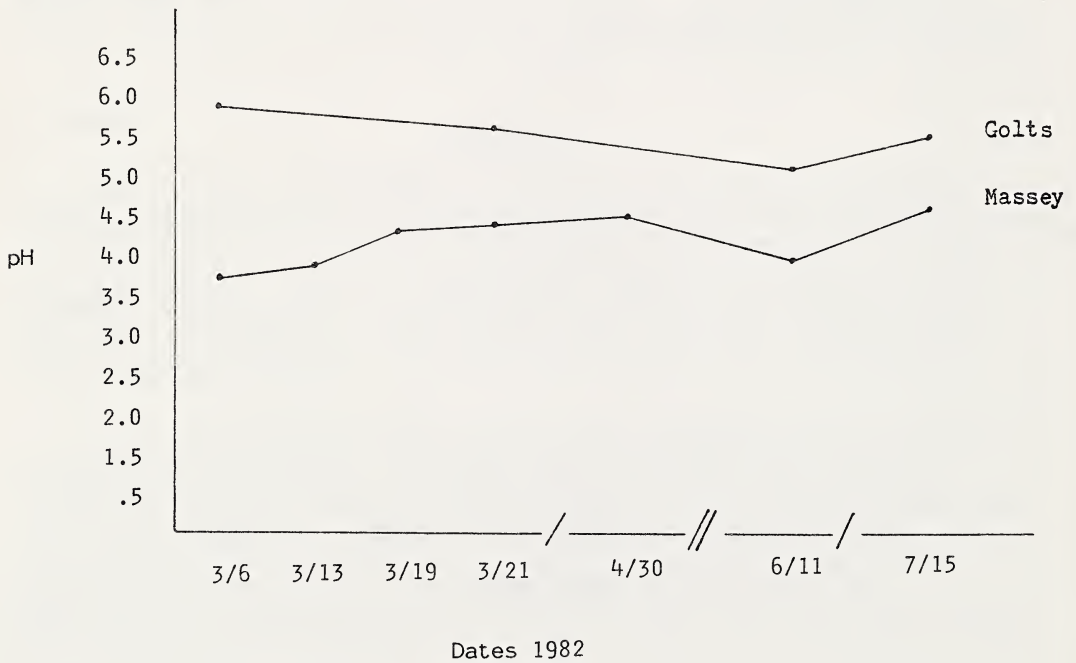


TABLE 3: pH DETERMINATIONS

DATE	MASSEY			GOLTS	
	EDGE OF POND	EGG MASS STAKES	CENTER OF POND	EDGE OF POND	EGG MASS STAKES
3/6/82	3.6	3.6	NA	NA	5.8
3/13/82	4.5	3.8	4.4	NA	NA
3/19/82	4.6	4.2	4.4	NA	NA
3/21/82	4.4	NA	4.5	5.5	5.5
4/30/82	4.4	4.5	4.9	NA	NA
6/11/82	NA	NA	3.8	5	NA
7/15/82	NA	NA	4.5	NA	5.4

NA = Not available



The dissolved oxygen content was consistently higher at Massey than at Golts. At Golts, the interface between pond surface and the atmosphere is restricted by aquatic vegetation. Additionally, the trees surrounding the pond inhibit breezes from blowing across the water thereby limiting turbulence and oxygen uptake. High density of various organisms competing within the pond for the oxygen and the decomposition of leafy debris on the pond bottom are additional factors that may limit oxygen availability for larvae.

Seining was conducted at both Massey and Golts on June 11 and June 16. Well developed *tigrinum* larvae were collected at both sites. The tolerance and adaptability of the tiger salamander was demonstrated by recovery of larvae from Golts on June 11 when the dissolved oxygen content was as low as 0.6 ppm. The increased gill size noted on larvae from Golts suggests a capability on the part of the tiger salamander for rapidly adapting to lowered dissolved oxygen. This suggests that eggs can hatch and that larvae can survive in water with a low oxygen content.

Anderson, et al. (1971) indicated that, as a result of their studies on three ponds, they observed that the mortality was higher in tiger salamander eggs found in one pond where the water had a lower pH (5.6-6.0) than the other two neutral ponds. Anderson, et al. (1971) suggested that perhaps low pH had a detrimental effect on the hatching success. They noted, however, that the assumption "seemed odd" as the pH range had no apparent impact on *opacum*. The present studies found the pH at Massey to be significantly lower than that at Golts, indicating that a pH level lower than that studied by Anderson, et al. had no effect on the hatching success of the tiger salamander. Massey Pond, where an active and prolific breeding colony has been consistently observed, ranged in pH from 3.6 to 4.9 for the spring of 1982. In contrast, Golts Pond ranged in pH from 5.0 to 5.8. Yet, no significant difference in hatching success was observed between the two ponds. It was concluded that the reduction in breeding at Golts was not related to a higher acid level of that pond since Massey was more acidic than Golts. In addition, this investigation indicates that embryonic development of the tiger salamander can occur in more acidic media than previously thought.

In general, the larvae developed and released at Golts appeared to be healthy. It had been previously thought that successional effects on water quality would have a detrimental effect on the hatching success at Golts contributing to termination of reproduction of the species at this site. However, these studies suggest that the difference in water quality between Massey and Golts apparently does not significantly affect survival. As a result of the hatching success of the encapsulated eggs translocated to Golts, successional effects on water quality would appear to have little or no effect. Since changes in water quality related to pond succession does not appear to have an effect on *A. tigrinum* egg masses when they were moved to Golts Pond, one must look to other factors to determine the reason tiger salamanders no longer breed at this site.

Conclusions

These investigations have suggested several conclusions regarding the survival of *tigrinum* in the environment.

1. The water quality at Golts Pond has not changed sufficiently to significantly alter the hatching success of *tigrinum* eggs.
2. In a protected enclosure, nearly 100% hatching success can be achieved in the pH range from 3.6 to 5.8 and a dissolved oxygen content from 0.6 to 11.8 ppm.
3. Larvae can adapt to a changing environment by changes in body coloring and gill size.
4. Translocation of egg masses apparently has no effect on the hatching success of tiger salamander eggs.

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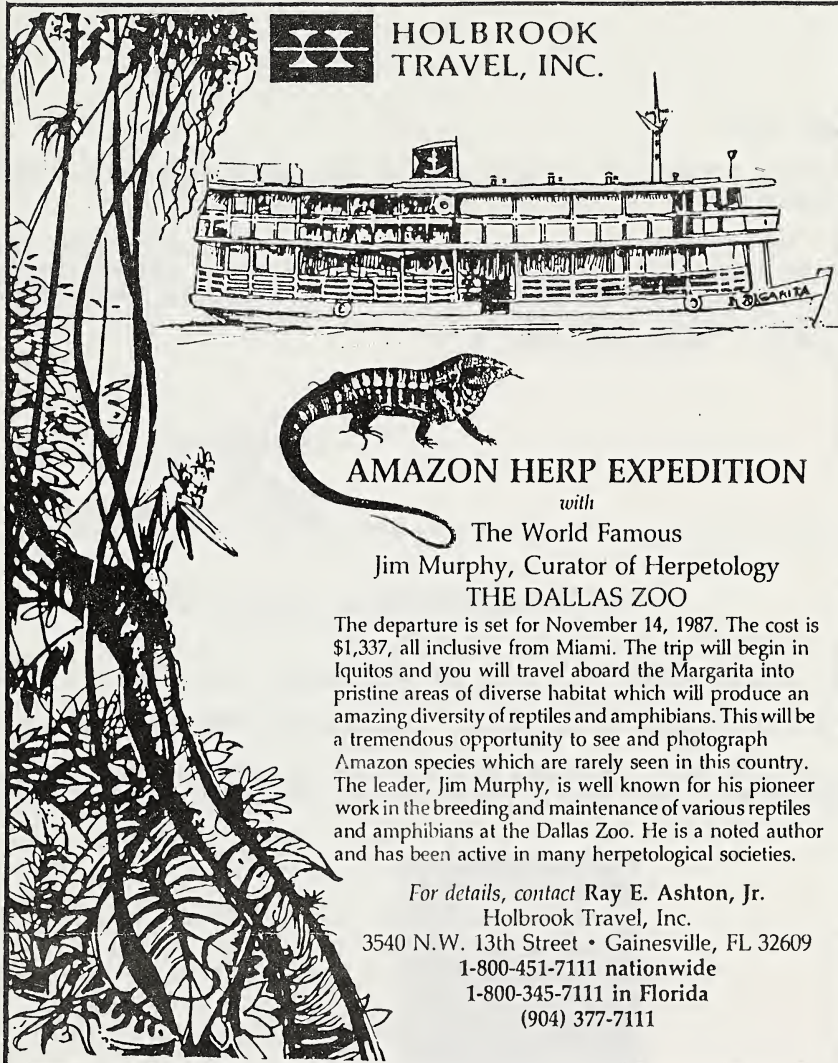
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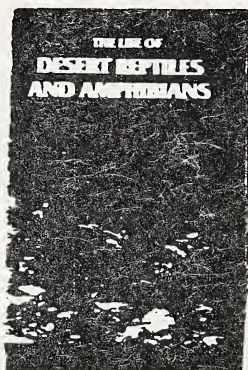

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VOLUME 23 NUMBER 3

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Volume 23 Number 3

September 1987

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EVAPORATIVE WATER LOSS IN THE TORTOISE *Gopherus berlandieri*
IN AMBIENT TEMPERATURE REGIMES

R. Earl Olson

In terrestrial organisms, losing tissue water to the environment is a limitation of time it can remain exposed to open air. The time of such exposure varies greatly in the Animal Kingdom, and may be different among members of the same taxon (Hall, 1922).

Studies of body water loss in tortoises and other dryland turtles have been made under various conditions, usually in desiccation devices or without provision of food or water. Cloudsley-Thompson (1970), studying *Testudo sulcata*, and Riedesel et al., (1971) gave data on daily water balance of studies involving desiccators. Benedict (1932), Bentley and Schmidt-Nielsen (1966), Bogert and Cowles (1947), Boyer (1965), Ernst (1968), and Schmidt-Nielsen and Bentley (1966) studied evaporative water loss in turtles in open air and deprived of food and water. Green (1972) investigated water turnover in free-living *Varanus gouldi* and presented a review of similar research. Preliminary data on body weight loss per 24 hours (BWL/24 hr) in *Gopherus berlandieri* fed regularly and exposed to ambient temperature and humidity have been published (Olson, 1976).

The present study provides data on % BWL/24 hr for multiple subjects of feeding *Gopherus berlandieri* exposed to ambient temperature and humidity and without benefit of a retreat burrow. Also included are weight regimes of tortoises of different sizes and the observed effect of 24 hr evaporative water loss in tortoises during the activity season and those subjected to different temperatures during the winter dormancy season.

Materials and Methods

Twenty-five *Gopherus berlandieri* (weights of 120 to 2150 grams) were variously housed under outdoor conditions or placed in enclosures in the field in Duval Co., Texas. During the summer activity season the tortoises were maintained in outdoor pens surrounded by $\frac{1}{4}$ -inch hardware cloth fence, and provided with cover, except during observation periods, when no cover was made available. The pens were similar to, but smaller than, those described by Kirsch (1967). In winter some animals were quartered in loosely-covered terraria at low temperatures. Weights were measured on a balance scale calibrated to the nearest 0.1 gram. Temperature data were obtained by telethermometer (Yellow Springs Instrument 42SF).

Tortoises were allowed to roam freely about the pens during summer activity season. During observation periods, the animals were provided only with food and water for one hour each morning, but were not allowed to retreat to cover. They were weighed before and after each feeding period; this procedure allows monitoring of weight loss between feeding (cf. Olson, 1976). However, when not being observed, the tortoises were periodically allowed continuous access to food, water and cover.

The data from the tortoises were separated according to weight classes. Data were grouped according to activity the temperature regime. The period of activity is defined as that season during which tortoises are regularly active and fed (May to October) daytime temperatures during the activity season were 28-40°C. Tortoises became dormant by mid-October in unheated laboratory conditions. Two dormancy temperature regimes were maintained, moderate (20-25°C) and cold (5-10°C), during which time tortoises were placed in loosely covered terraria (each for at least two months). Body weight loss is used as an index for evaporative water loss as it has been shown that the two factors are approximately equivalent (Schmidt-Nielsen and Bentley, 1966). Weight loss by excretion was measured by immediate direct weight loss of the tortoise (liquid excreta) or by weighing of the undried excreted pellet. Excretion weight data were not included in the daily weight loss data.

The animals were not permitted to retreat into burrows during either season to allow for periods of observation. However, a separate paper shows that a retreat burrow effectively reduces % BWL.

Results

Winter dormancy and BWL/24 hr.

Subjects maintained in the two different dormancy temperature regimes showed percentage BWL that is similar for all size groups at each of the temperatures, but differed considerably between the two regimes (Tables 2 and 3). The mean values are 0.014, 0.011, and 0.016g for the groups. A single 130g individual showed 0.059 % BWL/24 hr, indicating a potential for such high weight loss by larger tortoises, in observations over 1148 subject days (Table 3).

Activity season and BWL/24hr.

In the season of activity (May-October) tortoises maintained in outdoor pens were observed for 482 subject days. Observations show that an inverse relationship exists between % BWL/24 hr and tortoise weights. The daily weight loss of active tortoises of all weight classes were similar (Table 1). Mean grams per day (g/d) weight loss for all weight classes is 1.37 (0.7-2.1).

Table 1

Percentage BWL/24 hr in *Gopherus berlandieri*
during summer activity, without benefit of retreat cover.

Weight Range	Body Weight Loss X (Range)	G/D Loss	Subject Days
0-200g	0.78	1.0(0.4-1.8)	31
200-300g	0.35(0.33-0.37)	0.8	34
300-600g	0.28(0.19-0.42)	1.2(0.6-2.1)	144
600-900g	0.22(0.11-0.31)	1.6(0.7-3.3)	229
900-1400g	0.19(0.11-0.29)	2.0(1.3-3.7)	25
2000+g	0.05(0.03-0.07)	1.0(0.6-1.5)	30

Table 2

Percentage BWL/24 hr in *Gopherus berlandieri*
during winter dormancy at moderate (20-25°) temperatures without burrowing.

Weight Range	% Body Weight Loss	G/D Loss	Subject Days
200-300g	0.06(0.05-0.07)	0.17(0.15-0.19)	130
300-600g	0.09(0.05-0.12)	0.37(0.30-0.43)	316
600-900g	0.07(0.05-0.13)	0.53(0.40-0.65)	374
900-1400g	0.09(0.07-0.13)	0.67(0.60-0.77)	181
2000+g	0.015(0.014-0.016)	0.32(0.29-0.34)	147

Table 3

Percentage BWL/24 hr in *Gopherus berlandieri*
during winter dormancy at cold (5-10°) temperatures without burrowing.

Weight Range	% Body Weight Loss	G/D Loss	Subject Days
0-200g	0.059	0.07	31
300-600g	0.014	0.06	76
600-900g	0.011(0.005-0.015)	0.09(0.05-0.12)	161
900-1400g	0.016(0.003-0.06)	0.11(0.05-0.19)	303

Discussion

Evaporative water loss falls into at least two principal categories of water utilization in *Gopherus berlandieri*, one involving seasons of activity, the other winter dormancy, and possibly a third type during aestivation. Body temperatures are lower during aestivation dormancy than during times of activity (Voigt and Johnson, 1976). It cannot be assumed that one water-loss regime operates similarly in all dormancy situations.

During seasons of activity, free-living *G. berlandieri* show relatively low evaporative water loss to the environment even without benefit of a retreat burrow which tortoises dig in the wild. It appears that the evaporative water loss is low and could be continued without water replenishment for some time beyond that observed here. The % BWL/24 hr for *Gopherus berlandieri* is the most conservative known among species investigated under similar conditions. It is likely that very small individuals lose body water proportionately more rapidly, and very large individuals more conservatively than do those of sizes in between. Those values for *Gopherus agassizii* are close (Schmidt-Nielsen and Bentley, 1966) possibly at least as conservative as *G. berlandieri* in % BWL.

There is a reversal of daily weight loss from summer activity season to winter dormancy. During summer activity, the g/d loss is similar (Table 1), so that the % BWL shows much variation. In winter dormancy, the opposite occurs with a narrow range of variation in % BWL. The results of winter dormancy studies indicate that a more prolonged hibernation might be possible.

Evaporative water loss may be due to influencing factors and regulating mechanisms. To date most research has touched upon influencing factors, with some work regarding to the mechanisms of regulation. Influencing factors considered have been of extrinsic (temperature, humidity, insolation, and cover) and intrinsic (body size, temperature, blood pressure, activity, respiration, and possibly nutrition) natures.

Of extrinsic influencing factors, environmental temperature appears to affect such functions as respiration, circulation, activity and body temperature (Boyer, 1965; Hall, 1942; Heath et al., 1967; Hughes et al., 1971; Lumsden, 1924; Olson, 1976; Spray, 1972; Spray and May, 1972). Spray (1972) observed weight shifts in *Chrysemys picta* and *Terrapene ornata* during heating and cooling. Insolation increases body temperature of restrained turtles dramatically (Boyer, 1965), but aquatic turtles appear to do well compared with non-aquatic species when exposed to prolonged insolation (Boyer, 1965; Cloudsley-Thompson, 1966, 1970; McGinnis and Voigt, 1971; Morgareidge and Hammel, 1975; Riedesel et al., 1971; Sturbaum and Riedesel, 1974). Effects of humidity upon evaporative water loss are unclear. Cole (1943) has reported that basking lizards showed relatively rapid rise in body temperature under conditions of high humidity, and it might be more difficult to lose body water in those situations. But humidity variation and correspondent evaporative water loss results are not consistent (Green, 1972). Contrarily, utilization of cover brings about marked reduction in

evaporative water loss (Green, 1972; Krakauer et al., 1968; Olson, in preparation).

Intrinsic factors are more difficult to determine. There is increasing evidence that body temperature has a strong effect upon respiratory functions (Hall, 1924; Hughes et al., 1971; Lumsden, 1924) and blood pressure (Heath et al., 1967; Morgareidge and Hammel, 1975; Rodbard et al., 1950). Gucwinski et al., (1972) have shown that in *Geochelone gigantea* and *Testudo sulcata* there is considerable temperature variation with respect to body topography.

Nutritional state and food content are not clearly associated with evaporative water loss, but tortoises exhibit differential water retention with use of foods of high or low water content (Cloudsley-Thompson, 1970; Jayakar and Spurway, 1966; Olson, 1976). Liquid excretion was $\bar{X}=26.8$ (10.0-43; N=24) and accounted for much greater weight loss than did excretion of solid material: $\bar{X}=4.2$ (2.0-10.2; N=20).

Mechanisms of regulation of evaporative water loss in tortoises are only partially understood. Temperature heating the head (particularly when effecting the hypothalamus) and peripheral blood pressure are of considerable importance. Morgareidge and Hammel (1975) found that warming the hypothalamus resulted in increase in evaporative water loss, whereas cooling resulted in decrease. Heath et al., (1967) noted that such stimulation of the hypothalamus also affected blood pressure. But in both studies, effects were observed only at high (35-40°) body temperatures and thought to be ineffective at lower temperatures. Similar responses were not observed when other parts of the body were thermally stimulated. Individuals of *Gopherus berlandieri* do enter into retreat burrows head first, and remain in that position, thus not exposing the head to solar heating or to other immediate aspects of temperature.

Conclusions

Evaporative water loss in *Gopherus berlandieri* is low enough even without retreat cover that they can remain two or three weeks at warm temperatures (30-35°) with no deleterious loss of body water. It appears that fasting could be continued for more prolonged periods under these conditions.

In the summer activity season the % BWL/24 hr is inversely proportional to size of the tortoises. This is different from the situation observed during winter dormancy, during which % BWL/24 hr is similar for all size groups. It is suggested that there are seasonal or activity-related differences of utilization of energy reserve (Olson, 1976), regulatory mechanisms, and/or avenues of water loss.

Gopherus berlandieri is probably among the group of tortoises which demonstrate little evaporative water loss. Published data are not directly comparable because techniques differ, but there is some indication from them, and from initial studies of other species, that such is the case.

Factors thought to be important to evaporative water loss in turtles are regulatory functions and influencing factors. Influencing factors are of two sorts, extrinsic and intrinsic.

Acknowledgements

Some aspects important to this study were aided by Robert Hruska and Glennice Campbell. I thank Paul A. Ross for his help in the field.

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MINNESOTA HERPETOLOGICAL RECORDS

R. Earl Olson

There has been a considerable time since the appearance of Breckenridge's work (1944, Reptiles and Amphibians of Minnesota, Univ. Minn. Press), a period of time coupled with only scattered published records of herpetofauna of the state. No concerted effort has appeared in the four intervening decades. Following is a list of records of specimens gathered over the years which help to update such available material. All numbers are those of the author.

CAUDATA

Ambystoma laterale: Isanti Co., Springvale. REO 352-353, 403-404, 4070-4071, 4554, 4858, 4928-929.

Ambystoma tigrinum: Chisago Co.: REO 6139 (1.6 km N Rush City); Dakota Co.: 595-596 (FM #63, .8 km S U.S. Rte. 100); Isanti Co., Springvale: REO 246, 422, 612-614, 2667-669, 3736, 4236, 4240, 4301, 4555-557, 4884, 4886; 2673 (6.7 km N Cambridge); 2687 (7.5 km NW Cambridge); 3679 (1.6 km NW Cambridge); 3926 (2.4 km N Isanti); 4038 (4 km W Grandy); 4534-543, 4552 (Cambridge); 4898 (2.4 km S Dalbo); 4927 (1.6 km NW Cambridge); Mille Lacs Co.: 5584 (Princeton); 5605 (2.2 km E Princeton). 4038 (4 km W Grandy, 11 April 1974), 4534-4543 (Cambridge, 15 September 1975), 4552 (Cambridge, 28 September 1975), 4898 (2.4 km S Dalbo, 21 October 1978), 4927 (1.6 km NW Cambridge, 27 September 1979); Mille Lacs Co.: 5584 (Princeton, 18 March 1981), 5605 (2.2 km E Princeton, 28 March 1981).

ANURA

Bufo americanus: Aitkin Co. 3817-3818, 3826-3827 (5.8 km W, 2.7 km N Glen, 29 July 1973), 5997-5998 (7.5 km S Malmo, 25 September 1981); Chisago Co. 6034 (Taylors Falls, 28 May 1982), 6110-6111 (7.5 km E Rush City, 3 July 1982), 6121-6122 (Taylors Falls, 4 July 1982), 6138-6203 (1.6 km N Rush City, 12 May 1983), 6145-6147 (2.3 km S Rush City, 12 May 1983); Fillmore County, 5394-5403 (2.4 km E Mabel, 22 May 1980); Isanti Co. Springvale, 395-397 (July, 1952), 2660 (31 August 1971), 2826 (17 August 1970), 3357-3358 (15 June 1982); 3751 (6.7 km NW Cambridge, 6 May 1973), 3752 (7.5 km W Stanchfield, 6 May 1973), 3888 (Stanchfield Lake, 26 September 1973), 3889 (5 km N Cambridge, 26 September 1973), 6203 (13.3 km NW Cambridge, 21 June 1983); Kanabec Co. 5978 (10.3 km S Ogilvie, 25 September 1981); Lincoln Co. 5636 (Lake Benton, 21 May 1981); Lyon Co. 5637-5644 (Cottonwood, 23 May 1981); Morrison Co. 5672-5675 (8.5 km W Pierz, 14 June 1981); Swift Co. 5424, 5426 (E. Benson, 3 June 1980); Todd Co. 5665-5668 (15.6 km E Long Prairie, 13 June 1981); Washington Co. 5347-5350 (St. Croix River, 17 May 1980); Yellow Medicine Co. 5632-5634 (2.3-6 km N Canby, 22 May 1981).

Pseudacris triseriata: Isanti Co. 394 (Springvale, July 1952), 411 (Springvale, 1 September 1953), 6200-6202 (Maple Grove, 21 June 83).

Hyla crucifer: Aitkin Co. 3819-3820 (5.8 km W, 2.7 km N Glen, 29 July 1973); Chisago Co. 5355, 5357, 5365 (13.3 km SW Taylors Falls, 17 May 1980); Houston Co. 4807 (Hokah, 9 May 1980); Isanti Co. 392-393 (Springvale, July 1952), 402 (Springvale, 3 October 1954), 417-418 (Springvale, 3 October 1953), 2665-2666 (Springvale, 21 August 1971), 3877-3882 (Springvale, 21 September 1973); Washington Co. 5352-5354 (St. Croix River, 17 May 1980).

Rana catesbeiana: Houston Co. 5437 (Reno, 15 June 1980).

Rana clamitans: Isanti Co. 416 (Springvale, 9 July 1954), 2659 (Springvale, 21 August 1971), 2680 (Springvale, 20 October 1971), 3356 (Cambridge, 15 June 1972), 6204 (13.3 km NW Cambridge, 21 June 1983); Aitkin Co. 3823 (5.8 km W, 27 km N Glen, 29 July 1973); Chisago Co. 6035, 6041 (Taylors Falls, 28 May 1982), 6112 (8 km E Rush City, 3 July 1982), 6119-6120 (Taylors Falls, 4 July 1982); Kanabec Co. 6211 (5.3 km S Mora, 15 July 1983), 6216 (10.6 km S Mora, 15 July 1983).

Rana pipiens: Aitkin Co. 6001-6002 (2.4 km S Malmo, 25 September 1981); Isanti Co. Springvale: 357-375 (July 1982), 399-400 (August 1952), 412 (1 September 1953), 2654-2658 (21 August 1971), 2678-2679 (20 October 1971), 2827 (30 June 1970), 3737-3748 (21 April 1973); 3890 (5 km N Cambridge, 26 September 1973), 4039-4046 (Stanchfield Lake, 11 April 1974), 4049-4053 (Grandy, 11 April 1974), 4057 (Cambridge, 20 April 1974), 6019 (9.5 km E Dalbo, 30 October 1981), 60630-6032 (Spectacle Lake, 24 April 1982); Kanabec Co. 5971-5972 (1.6-3.8 km E Ogilvie, 26 August 1981), 5979-5987, 5989 (11.7 km S Ogilvie, 25 September 1981), 6022 (Groundhouse River So. Mora, 21 June 1983), 6212-6215 (10.7 km S Mora, 15 July 1983), 6217-6218 (8.8 km S Mora, 15 July 1983); Chisago Co. 6016-6017 (1.6 km N Rush City, 10 October 1981); Mille Lacs Co., 5415 (5.8 km E Princeton, 25 May 1980), 5583 (Princeton, 28 May 1981), 6007-6009 (11.7 km W Princeton, 9 October 1981); Morrison Co. 5669 (8.5 km W Pierz, 14 June 1981).

Rana septentrionalis: Crow Wing Co. 421 (Trout Lake); Isanti Co.: 11651-11652 (5 mi. SE Weber).

Rana sylvatica: Aitkin Co. 4068-4069 (5.8 km W, 2.7 km N Glen, 25 May 1974), 5999-6000 (So. Malmo, 25 September 1981); Anoka Co. 4054-4056 (Bethel, 20 April 1974); Chisago Co. 6137 (3 km N Harris, 12 May 1983); Crow Wing Co. 420 (Trout Lake, 20 September 1954); Isanti Co. 376-387 (Springvale, August 1952), 2661-2663 (Springvale, 31 August 1971), 2688 (Springvale, 19 August 1971), 2628-2629 (Springvale, 17 August 1970), 3883, 3887 (Springvale, 21 September 1973), 4047-4048 (Springvale, 11 April 1974), 4551 (Cambridge, 28 September 1975); Kanabec Co. 5973 (3.8 km N Ogilvie, 26 August 1981), 5988 (11.7 km S Ogilvie, 23 September 1981); Mille Lacs Co. 5415 (5.8 km E Princeton, 25 May 1980), 5577-5582 (4.8 km E Princeton, 28 May 1981), 5992-5994 (8.3 km NNE Isle, 25 September 1981); Todd Co. 5653 (17.5 km E Long Prairie, 13 June 1981).

TESTUDINES

Chelydra serpentina: Big Stone Co. 6151 (11.7 km E Ortonville, 27 May 1983); Isanti Co. 401 (Springvale, August 1952), 3678 (Springvale, 12 August 1972), 4581 (Cambridge, 15 May 1976), 4883 (Twin Lakes, Oxford Twp., 20 September 1978), 5575 (8.3 km NW Cambridge, 1 March 1981); Washington Co. 6370 (Forest Lake, 14 June 1984); Winona Co. 6058 (Winona, 30 May 1982).

Emydoidea blandingi: Anoka Co. 6207 (2.4 km N East Bethel, 24 June 1983); Chisago Co. 6210 (North Branch, 8 July 1983), 11477 (1.6 km W Wyoming, 7 June 1984); Isanti Co. 4413 (Springvale, 1 July 1975), 4574 (Cambridge, 1 April 1976), 4889 (20 km E Isanti, 27 September 1978), 6027-6029 (5 km NW Isanti, 25 February 1982), 11444 (1.6 km S Weber, 14 May 1984, 11445 (Typo Lake, 14 May 1984); Kanabek Co. 11672 (5 mi. NW Braham, 17 July 1987).

Chrysemys picta: Aitkin Co., 4067 (9.2 km S Glen, 5 May 1974); Goodhue Co. 4806 (5.7 km N Frontenac, 9 May 1980); Isanti Co. 3680 (1.2 km NW Cambridge, 3 September 1972), 3756 (Cambridge, 25 May 1973), 4034 (Cambridge, 1 April 1974), 4228-4231 (Springvale, 2 September 1974), 4252-4253 (3.2 km N Isanti, 20 September 1974), 4297-4299 (Springvale, 21 October 1974), 4233-4235, 4242, 4246-4247, 4252-4253 (3.2 km N Isanti, 20 September 1974), 5686 (5 km NW Cambridge, 14 June 1981); Swift Co. 5422 (14.8 km E Benson, 3 June 1980), 5423 (18.2 km E Benson, 3 June 1980).

SERPENTES

Lampropeltis triangulum: Olmstead Co. 6265-6172, 6176-6188 (10 km S Marion, 29 May 1983).

Opheodrys vernalis: Isanti Co. 323-325 (Springvale, 23 July 1951), 345 (Springvale, 1 October 1951), 408 (Springvale, 6 September 1953), 592 (2.8 km W Stanchfield, 7 September 1963).

Pituophis melanoleucus: Chisago Co. 4890 (1.6 km E Sunrise, 27 September 1978), 5370 (9.3 km E North Branch, 17 May 1980), 6369 (3.2 km N Stacy, 14 June 1984), 11480 (1 mi. N Stacy, 27 June 1984), 11481 (1 mi. N Wyoming, 27 June 1984), Isanti Co.

Storeria dekayi: Isanti Co. 339-341 (Springvale, 17 August 1951).

Thamnophis radix: Chisago Co. 6033 (Taylors Falls, 28 May 1982); Isanti Co. 337 (Springvale, July 1951), 347 (Springvale, 8 July 1952), 406 (4.2 km S Isanti, August 1953), 415 (3.2 km NW Cambridge, 6 July 1954), 593 (Springvale, 7 September 1963), 2672 (1.6 km NW Cambridge, 31 August 1971), 2676-2677 (Cambridge, 30 September 1971), 2685-2686 (Springvale, 20 October 1971), 3352 (5 km NW Cambridge, 3 June 1972), 3925 (3.2 km NW Cambridge, 15 November 1973), 3359 (5 km NW Cambridge, 15 June 1972), 3753-3754 (6.7-7.5 km NW Cambridge, 8 May 1973), 3891 (0.8 km N Cambridge, 1 October 1973), 4072 (Cambridge, 5 May 1974), 4227 (6.7 km Cambridge, 20 August 1974), 4300 (Cambridge, 21 October 1974), 4893 (Bradford, 11 October 1978), 4894 (16.7 km

NW Cambridge, 11 October 1978), 4895 (6.7 km W Orrock, 17 October 1978), 4896 (5 km N Dalbo, 19 October 1978), 4926 (Springvale, 27 September 1979), 6005 (1.6 km W Grandy, 9 October 1981), 6018 (Cambridge, 30 October 1981).

Thamnophis sirtalis: Aitkin Co. 3831 (5.8 Km W, 2.7 km N Glen, 20 August 1973); Isanti Co. 320-322 (Springvale, June 1950), 331 (Springvale, 18 July 1951), 332, 334-336 (Springvale, August 1951), 342-344 (Springvale, 23 September 1951), 354 (Springvale, July 1952), 407 (Springvale, August 1953), 2670-2671 (Springvale, 31 August 1971), 2682-2684 (Springvale, 20 October 1981), 3361 (1.6 km NW Cambridge, 15 June 1972), 3676-2677 (6.7 km NW Cambridge, 11 August 1972), 3868 (Springvale, 1 September 1973), 4212 (Springvale, 8 August 1974), 4237-4239, 4249 (Springvale, 2 September 1974), 4885, 4888 (Springvale, 27 September 1978), 5570-5573 (NW Cambridge, 1 October 1980), 5694 (Cambridge, 30 June 1981), 5975 (1.6 km W Grandy, 5 September 1981), 5976 (1.6 km NW Cambridge, 10 September 1981), 6004 (3.2 km E Dalbo, 9 October 1981), 6107 (1.6 km E Grandy, 31 August 1982), 6124 (Bradford, 20 October 1982, 6209 (Cambridge, 7 July 1983).

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THE CUBAN GREEN ANOLE (*Anolis porcatus*):
A COLONIZING SPECIES

Thomas Vance

The Cuban green anole, *Anolis porcatus*, is commonly found throughout the island of Cuba and its surrounding cays. Through different forms of human influence, it has been transported to several localities where it appears to be doing well as a colonizer. This report briefly reviews the relevant literature regarding the transportation of this lizard to various localities along with several new distributional records.

A. porcatus has been introduced in several localities of Republica Dominicana (Hispaniola), and it is known to exist in Santo Domingo (La Feria) and 5.4 km N of Carretera Duante from the junction with the Avenida Abraham Lincoln in Santo Domingo, Distrito Nacional (Schwartz and Thomas, 1975; Schwartz et al., 1978; Garrido and Jaume, 1984). It is also to be known from the United States, but the type locality "Texas" is to be considered as a mistaken locality record (Gray, 1840; 1845; Boulenger, 1885). The anole is reported from Key West, Florida, which may have been the result of introductions by fruit boats (Allen and Slatten, 1945; Smith and Kohler, 1977), yet specimens are unavailable for study; it is not thought by this author that a population is in existence.

A third region of introduction is the Hawaiian Islands of the Pacific. *A. porcatus* is known to exist in thriving populations in the residential neighborhoods throughout Oahu and at several locations in Hilo and Kailua, Hawaii and Manoa Valley, Maui. Here, it is often sold in pet shops and is the only diurnal and arboreal insectivore. The anole was established in the Kaimuki district of Oahu in 1950 through the release of pet store imports and may eventually turn up on other islands of this group (Shaw and Breese, 1951; Oliver and Shaw, 1953; Hunsaker and Breese, 1967; Cochran and Goin, 1970; Flint, 1972; Anon, 1972; Smith and Kohler, 1977; McKeown, 1978; Jones, 1979; Wilson and Porras, 1983; Chan et al., 1987).

The author of this paper notes the establishment of *A. porcatus* on the Pacific Islands of Guam and Saipan. These localities are represented by specimens in the collections of the American Museum of Natural History (AMNH), Los Angeles County Museum of Natural History (LACMNH), and the United States National Museum (USNM). USNM 192873, collected by Marjorie Falanruw on July 12, 1967 in Tumon, Guam, is a male in reproductive condition; USNM 192874 is a male in reproductive condition collected on June 21, 1968 from the same locality; USNM 192877 is a male collected on June 30, 1968, reproductive condition unknown, yet other data remains the same as the first two; USNM 192875 is a male of unknown reproductive condition collected by Marjorie Falanruw at the Naval Air Station Terminal, Guam, on June 21, 1968; USNM 192876 taken by the same collector on June 22, 1968, at Tamuning, Guam, is a female of unknown reproductive condition; USNM 192892 is an individual

taken by the same collector on February 4, 1969, from Dededo, Guam; USNM 216318 is an individual collected by Cynthia Cheung on January 28, 1977, from Dededo, Guam; USNM 216316 is a male collected by Judith Abrams on January 23, 1977 from the Federal Aviation Authority Housing, South Finegayan, Guam; USNM 216317 is an individual collected by Prospero Guieb on May 2, 1976 at 1600 hours from Harmon, Guam; USNM 216319 is an individual collected by Jeanne Ballinger on April 21, 1976, at Barrigada, Guam; AMNH 74536 is an individual taken from Piti, Guam; and other specimens referable as Guam material are LACMNH 61495-97. In addition, *A. porcatius* is known to exist on the island of Saipan. This is indicated by USNM 212384-86, 257649, and 257650 collected from trees near jetties at the Oleai area, Susupe, and San Vicente. Their method of entry remains unclear, but they are morphologically similar to the Guam examples. Also, they exist on Managoha Island off Saipan (USNM 257646).

The specimens from Guam and Saipan agree closely with the photographs of the Hawaiian examples by McKeown (1978), yet Ruibal (1964) is unable to connect the Hawaiian lizards with a particular Cuban locality of origin and suggest "Habana" as the possible point of export. The current author, upon examining McKeown's (1978) reference and the specimens from Guam and Saipan, is of the opinion that their origin is from the area of Las Villas or perhaps Camaguey Provinces, Cuba, where an eastern morph of *A. porcatius* may merge with a central one. The Guam examples probably arrived from Hawaii and were perhaps transferred to Guam, Saipan, and Managoha Island unintentionally by the military.

This author has noticed the presence of small ticks, numbering as many as ten, within the ear of several individuals (USNM 27360-61) from Pinar del Rio, Cuba, but the specimens from Guam and Saipan do not show evidence of external parasitism. It is possible that the introductions do not have many predatory or parasitic enemies on the Pacific Islands. The ecological effects of the *A. porcatius* on the flora and fauna of these islands, however, cannot be determined.

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INTRASPECIFIC KLEPTOPARASITISM AND AGGRESSION
IN YOUNG, CAPTIVE RED-EARED SLIDERS
(*Pseudemys scripta elegans*)

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Abstract

Young, captive red-eared sliders (*Pseudemys scripta elegans*) readily steal food from the mouth or claws of feeding conspecifics. Unlike other species of turtles, other aggressive behaviors rarely occur during these kleptoparasitic attacks. The frequency of kleptoparasitism appears to be inversely proportional to the quantity of food in the aquarium. Several ecological conditions which may facilitate the occurrence of kleptoparasitism in wild populations of reptiles are discussed.

Kleptoparasitism, the interspecific and intraspecific stealing of already procured food (Brockmann and Barnard, 1979), is seldom reported in reptiles. Anecdotal reports indicate that several genera of snakes (*Thamnophis* and *Nerodia*), lizards (*Sceloporus* and *Anolis*) and turtles (e.g., *Chrysemys*, *Terrapene*, and *Kinosternon*) attempt to steal food from captive cagemates when given the opportunity (Boice, 1970; Greenberg, 1976; Harless, 1979; Mahmoud and Klicka, 1979; Burghardt and Denny, 1983; Hayes, 1986). However kleptoparasitism has never been studied or discussed in detail in any reptile. In this paper I report my observations of intraspecific kleptoparasitism and aggression in young, captive red-eared turtles (*Pseudemys scripta elegans*), and discuss the ecological factors which might facilitate the occurrence of kleptoparasitism in wild populations of turtles.

Methods

In March and April 1986, I maintained five young red-eared turtles (33-36 mm straight carapace length), purchased from a pet shop, in a 38 liter aquarium with a rock occupying approximately 25% of the horizontal surface area, and water at a depth of 7-8 cm covering the remaining surface area. The turtles were subjected to a 12:12 light:dark photoregime, with the onset of light at 0700. Water temperatures ranged from 18.3°C at night to 23°C during the day, and air temperatures ranged from 19.4°-25.0°C.

Nearly every morning between 0730 and 0900, I tossed small (0.5-1.0 cm) chunks of freeze-dried tubifex worms (*Tubifex* spp.) into the water. Three of the turtles fed regularly, usually seizing the chunks at the surface and swallowing them underwater. One or both of the forelegs were frequently used to help tear smaller pieces of worms from the original chunks, and pieces of food were often snagged by the claws. For each piracy attempt by the turtles I recorded the success or failure of the attempt, whether the attack was aimed at food in the mouth or in the claw, and whether or not any aggressive interactions occurred. One sample and two sample chi-square tests were used when appropriate (Siegel, 1956) to analyze the data.

Results

On 115 occasions I observed turtles attempting to grab food from the mouth or claw of another turtle. There were no significant differences in the success rates of turtles stealing food from the claws (65.6%) or from the mouth (55.6%; $\chi^2 = 0.82$, $df = 1$, $P = 0.36$), or in the frequency of turtles attempting to steal food from the claws ($n = 61$) or mouth ($n = 54$; $\chi^2 = 0.43$, $df = 1$, $P = 0.52$). Considering both methods, the overall success rate was 60.9%. During 9 attempts the claw was inadvertently grabbed by the attacker; 4 (44.4%) of these attempts were successful. When they occurred, the host merely pulled back its leg; only once did a host bite the attacker in the claw in apparent revenge. When robbed from the mouth, victims often pushed off from the attacker with their forelegs. Other evasive maneuvers were rarely observed; on one occasion a turtle with food turned away from a potential attacker in an apparent attempt to avoid kleptoparasitism.

Discussion

The relative absence of aggression in *P. scripta* during kleptoparasitic attacks seems surprising since captive individuals of painted turtles (*Chrysemys picta*), box turtles (*Terrapene carolina*), and various kinosternid and emydid turtles frequently chase and bite at turtles holding food in their mouths (Boice, 1970; Harless, 1979; Mahmoud and Klicka, 1979; Hayes, 1986). Burghardt and Denny (1983) observed that common garter snakes (*Thamnophis sirtalis*) in captivity and in the field frequently pursued individuals with a worm hanging from their jaws, and that the pursued snakes attempted to elude their pursuers by racing away with the head held high in a distinctive posture. Captive blue spiny lizards (*Sceloporus cyanogenys*) with food in their jaws also retreated when pursued by conspecifics (Greenberg, 1976).

The relative absence of aggression in *P. scripta* may have been due to the abundance and regularity of food in the aquarium. Greenberg (1976) noted that the frequency of kleptoparasitism in *Sceloporus cyanogenys* was inversely proportional to prey density. Similarly, I obtained data more quickly when only a single chunk of *Tubifex* worms was placed into the aquarium at a time; when a surplus of food was available the turtles attempted kleptoparasitism less frequently. However, aggressive behaviors were still rare regardless of the amount of food available or when the turtles were not fed for a week. It could be that *P. scripta* is simply less aggressive when feeding than most of the other turtle species.

Moll and Legler (1971) regarded *P. scripta* as solitary. However, on several occasions they observed both captive and wild juveniles eating epizootic algae (presumably *Basilecladia*) from the shells of other juveniles, indicating that social interactions between juveniles occur in the wild. Bjorndal (1986) demonstrated that captive, juvenile Florida red-bellied turtles (*P. nelsoni*) ingest more food when in groups than when solitary, suggesting that social interaction in the form of a visual feeding stimulus is responsible for this increased intake of food. Kleptoparasitism in

P. scripta also appears to be a consequence of social interaction, and is apparently stimulated by the sight of a feeding turtle. But whether kleptoparasitism is merely an artifact of captivity or occurs in the wild as well remains to be learned.

Although kleptoparasitism has never been observed in wild populations of turtles or other species of reptiles, several ecological conditions may facilitate its occurrence. Brockmann and Barnard (1979) enumerated six such conditions which may have facilitated the evolution of kleptoparasitism in birds: (1) large concentrations of hosts; (2) large quantities of food; (3) large, high-quality food items; (4) predictable food supply; (5) food visible; and (6) shortage of food. Paulson (1986) pointed out that the "food visible" condition is a consequence of another important condition, the openness of the habitat, which has four effects: (1) potential and actual hosts can be watched, even continuously, at a longer distance; (2) capture and carrying of prey is visible for a longer distance; (3) hiding from kleptoparasites is difficult or impossible; and (4) prey items can be found easily after they are relinquished by the host.

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COMMENTS ON GEOGRAPHIC VARIATION IN
Rhinoclemmys areolata (TESTUDINES)

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Abstract

The population of *Rhinoclemmys areolata* in western Tabasco and adjacent Veracruz, México, is primarily aquatic and differs structurally, in color pattern and in behavior from the savanna-dwelling population of south-central Veracruz; both appear to represent distinct taxonomic units. The Veracruz unit appears to range south of the Tabasco population, extending eastward into Petén, Guatemala, and northward into Campeche. The populations of Isla Cozumel, northern and eastern parts of the Yucatán peninsula, Belize and Honduras, appear to constitute a third distinctive unit.

In surveying the turtles of Veracruz and adjacent areas, one of us (GPH) discovered that the population of *R. areolata* inhabiting western Tabasco and immediately adjacent Veracruz differs sharply and markedly from the population of south-central Veracruz in behavior, habitat and color pattern. Specimens observed or studied of the Tabasco/Veracruz population number 29, including UNAM-LT (Universidad Nacional Autónoma de México, collection of the Estación de Biología Tropical Los Tuxtlas) 3017 ♂, 3029 ♂, adults from a swamp at the airport, Villahermosa, Tabasco, México, April, 1984, GPH collector; 3021 ♂, Colonia Las Gaviotas, Villahermosa, GPH; 3023 ♂, km 2.5, hy 195 SE Villahermosa, GPH; 3020 ♀, 3022 ♀, 3028 ♀, Cd. Pemex, Tabasco, GPH; 3026-7 ♀♀, Paraiso, Tabasco, GPH; 3025 ♂, Dos Bocas, Tabasco, GPH; and 3024 ♀, Tonalá River, Los Soldados, Veracruz, GPH. Additional uncataloged examples include one each from Teapa and Ejido Emiliano Zapata, Tabasco, and 16 ♂♂ living in the zoo (Centro de Convivencia) in Villahermosa, from various localities in the vicinity of Villahermosa. All these specimens represent the distinctive population here termed the "T/V" (Tabasco/Veracruz) group.

From south-central Veracruz, 18 specimens have been examined, including ten in the UNAM-LT collection (Cd. Alemán [3118-9]; Isla [3126]; Matzumiapan [3018, 3120-5]; Alvarado (uncataloged); and seven in the possession of Sr. Loreto Xolotl of Camacho, Veracruz (one from Isla, six from the vicinity of Camacho). All these constitute what we here term the "SCV" group. The localities of both the T/V and SCV groups are indicated on the accompanying map (Fig. 3).

The T/V population differs from the SCV group as follows (latter in parentheses): gular region invariably unspotted (Figs. 1A, 2A) (invariably dark-spotted; Figs. 1B, 2B); hind legs invariably uniform dark above, usually unspotted below (Figs. 1A, 1C, 2C) (invariably lighter, black-spotted above and below; Figs. 1B, 1C, 2D); carapace invariably lacking a keel, or weakly keeled, in adults (Fig. 1C) (invariably strongly keeled; Fig. 1D); growth rings invariably smooth, not ridged, in adults (Fig. 1C) (invariably prominently ridged; Fig. 1D); carapace always gray-olive (always brown). Less trenchant but diagnostically useful differences: red supratemporal

stripe narrow, interrupted or curved about tympanum, not extending posteriorly onto neck, in 88% (Fig. 2A) (broad, straight, uninterrupted, extending onto neck, in 100%; Fig. 2D); paired median dorsal red spots or stripes on neck absent in 92% (invariably present); length of abdominal scute 25% or less length of plastron, in 92.3% (Fig. 1A) (invariably much more than 25%; Fig. 1B). Other significant differences not individually diagnostic: central dark figure on plastron usually extending laterally just to middle of scutes (Fig. 1A) (usually extending laterally beyond middle of scutes; Fig. 1B); usually a single axillary scute (usually two larger scutes, and one very small); usually no or 2-3 tiny inguinal scutes (usually two larger, subquadrangular scutes); posterior supraocular red spot absent in 39.5% (Fig. 2A) (always present; Fig. 2B); bridge contacting three marginals in 40% (Fig. 1A) (four in 100%; Fig. 1B); maximum length 130 mm (160 mm).

The T/V population inhabits permanent swamps and sluggish, lowland rivers, is primarily aquatic, and has typical aquatic courtship patterns. Specimens are encountered most frequently once the rainy season is well under way, in summer and winter; several have been found as early in their activity season as July, and as late as February. On the contrary, the SCV population has markedly different habitat preferences, occurring in savanna regions rather than in permanent swamps; it is primarily terrestrial, exhibits terrestrial courtship behavior and is encountered most frequently at the beginning of the rainy season, in June and July.

Although the difference here noted in conspicuousness of the carapacial keel and growth rings are commonly attributed to wear, young (small) animals exhibit the differences as well as older (larger) ones, and therefore the distinction is regarded as genetic.

In addition to the SCV and T/V material cited above, eight from nearby areas to the east conform completely with the SCV population, and presumably represent the same taxonomic unit, which may well be distributed continuously south of the T/V taxonomic unit (Fig. 3). Those eight are: El Paraíso (UNAM-LT 227, 455) and Cd. del Carmen (one, GPH pers. coll.), Campeche; Catazajá (UNAM-LT 1587) and Palenque (one, uncataloged), Chiapas; and Jonuta, Usumacinta Basin (three, GPH pers. coll.), Tabasco. Data kindly supplied by Dr. J. B. Iverson for a specimen from Tecolapan, Veracruz, also conform, insofar as available, with our SCV material, as would be expected on geographic grounds.

However, specimens examined from Isla Cozumel, Quintana Roo (UNAM-LT 2036-2044, R. C. Vogt) do not conform fully with either the SCV or T/V population; the carapace color (gray) and immaculate throat resemble those of the T/V population, the proportions of the abdominal scutes are intermediate, and all other diagnostically useful character-states resemble those of the SCV population. Like the latter, the Cozumel population is primarily terrestrial, remaining buried through much of the distinctive, long dry season, and appearing in abundance in the rainy season (R. C. Vogt, pers. comm.). However, the Cozumel population reaches larger size than others (206 mm carapace length fide Ernst, 1980), and is also distinctive in certain proportions (Ernst, 1978: 118), suggesting that it may well be a taxonomic unit separate from the ones represented by our T/V and SCV series.

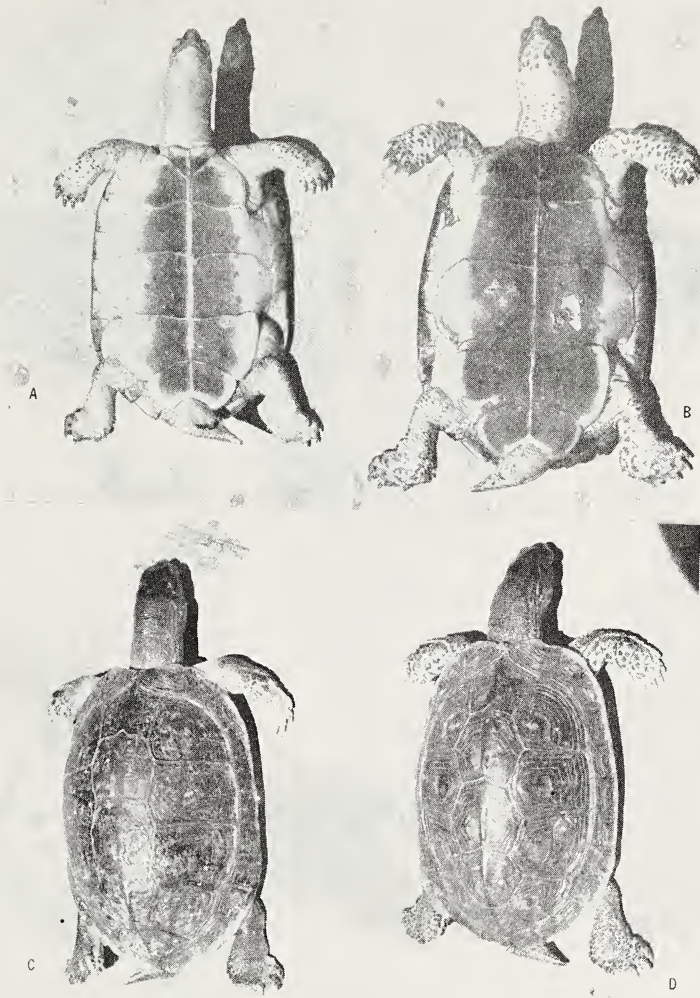


Fig. 1. A, C, *Rhinoclemmys areolata* of the Tabasco/Veracruz population, UNAM-LT 3017 ♂, Villahermosa, Tabasco (carapace length 127 mm, width 88 mm; shell height 53 mm, plastron length 111 mm). Note immaculate throat and ventral surfaces of hind legs, uniformly dark dorsal surfaces of hind legs, narrow dark central plastral figure, reduced carapacial keel, smooth growth ridges. B, D, *R. areolata* of the south-central Veracruz population, UNAM-LT 3018 ♂, Camacho, Municipality Isla, Veracruz (carapace length 156 mm, width 109 mm; shell height 156 mm; plastron length 138 mm). Note spotted throat and hind legs (both dorsal and ventral surfaces), wide dark central plastral figure, prominent carapacial keel, raised growth ridges.

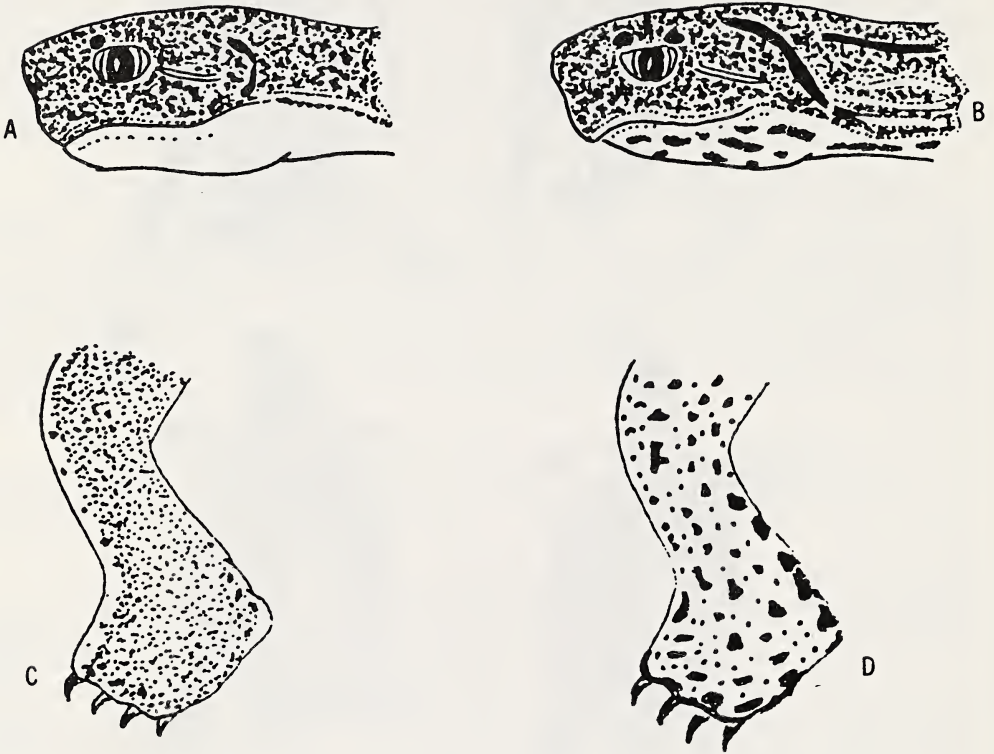


Fig. 2. Lateral view of head (A, B) and dorsal view of hind leg (C, D) of *R. areolata*; Tabasco/Veracruz population, UNAM-LT 3017 (A, C), and the south-central Veracruz population, UNAM-LT 3118, Cd. Alemán, Tabasco (B, D).

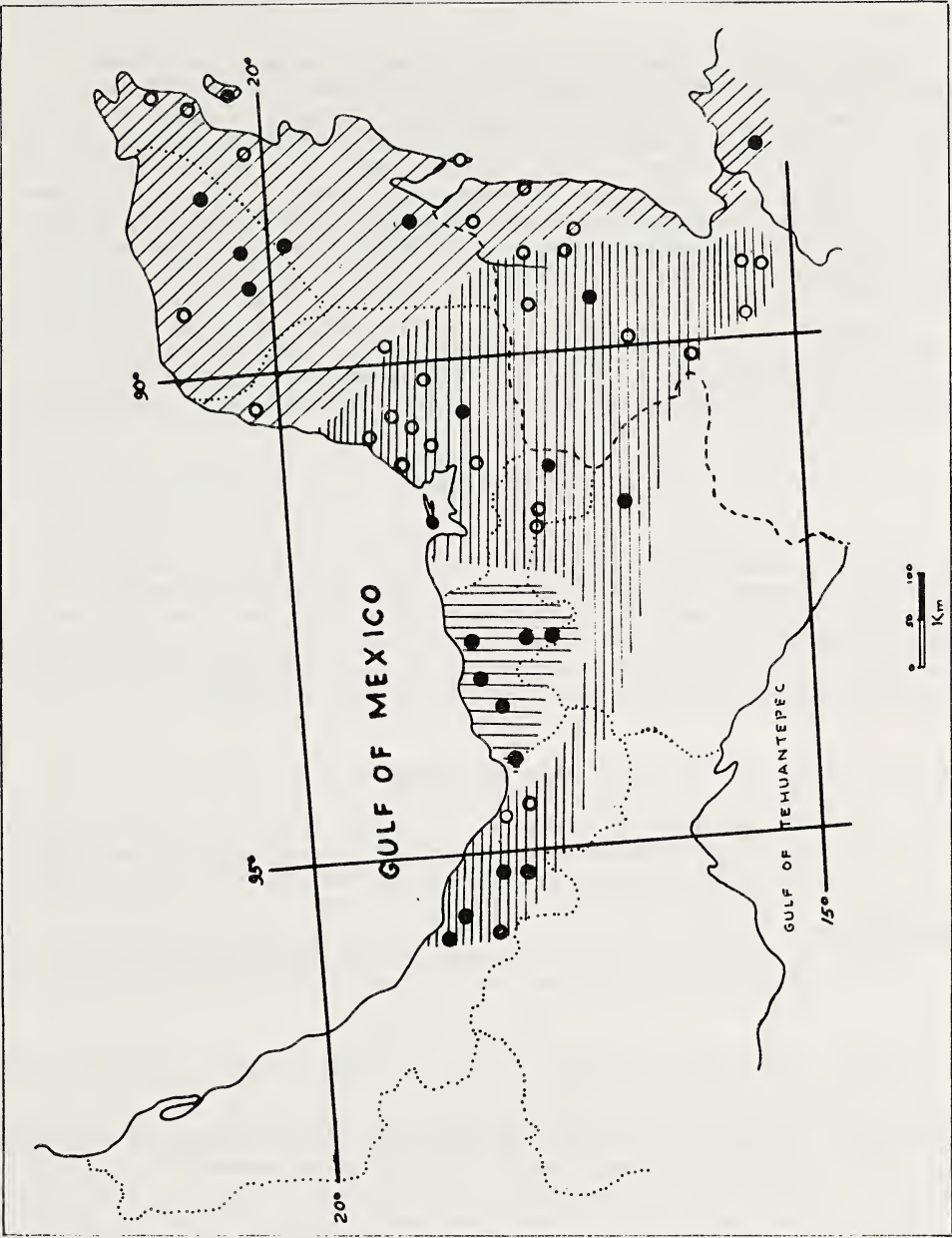


Fig. 3. Projected distribution of *Rhinoclemmys areolata* and its presumed taxonomic units, indicated by different line directions. Boundaries between ranges based in part on Iverson (1986: 64). Dots represent localities of specimens examined by GPH or Iverson, or for which at least some data were available for the present review; circles represent literature records.

Data kindly supplied by Dr. John B. Iverson for specimens from Valladolid and Piste, Yucatán, and from Quintana Roo (Chetumal, Puerto Morelos), Honduras (San Pedro Sula), Guatemala and Belize suggest that they belong to the Cozumel taxonomic unit (Fig. 3), but we do not have access to sufficient material to resolve that problem. Material from the type locality (Petén, Guatemala), as described in Duméril and Duméril (1851:13), conforms with the SCV group, and thus represents that same taxonomic unit. The T/V unit is apparently restricted completely to western parts of Tabasco and adjacent Veracruz (Fig. 3).

Inasmuch as it is impractical for us to examine all material in American and European museums to determine the full range of geographic variation in *R. areolata*, we can only point out that at least three geographic races of the species appear to await recognition in the future.

Acknowledgments

We are particularly indebted to Dr. John B. Iverson for critically important counsel and data; Drs. Peter Meylan and Richard C. Vogt for advice; Sr. Silvestre Ortega, zoological curator of the Centro de Convivencia, Villahermosa, Tabasco, for permission to study the turtles under his care; Dr. Rodolfo Dirzo, director of the Estación de Biología Tropical Los Tuxtlas, for support and facilities; Sr. Adolfo Ibarra, for the photographs; and to two anonymous reviewers of an early version of the manuscript.

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UPDATED DISTRIBUTION OF THE BLANDING'S TURTLE,
Emydoidea blandingi, IN MAINE

Given the paucity of Maine records for the Blanding's turtle, *Emydoidea blandingi*, it has been difficult to assess the distribution of this rare chelonian. This brief report will attempt a synthesis of all records (both historical and recent) to better define the current status of *Emydoidea* in Maine.

Literature records for Maine *Emydoidea* include Packard (1960) and Graham and Doyle (1973). Table 1 summarizes our knowledge of the status of *E. blandingi* in Maine since the first specimens were reported by Packard (1960). All records since 1980 resulted from the combined efforts of the Maine Amphibian and Reptile Atlas Project (MARAP), a volunteer atlasing effort, and field work conducted by TEG and JEF in 1985 and 1986.

Only four of the turtles reported since 1980 were actually trapped (fyke nets and baited funnel traps) in a specific body of water. All other records are for turtles found traversing roads or uplands. It can only be suspected that these individuals were associated with breeding populations in the nearest suitable habitat. In all cases the closest probable aquatic origin was either a pond or lake (usually containing swampy portions) or boggy areas associated with small streams or rivers.

These data demonstrate that the distribution of the Blanding's turtle in southern Maine is less spotty than previously assumed. Although we do not yet have confirmed reports for specimens seen or taken outside of York County, we feel that increased public awareness and interest in the distribution of the state's herpetofauna will ultimately lead to the discovery of *Emydoidea* in Cumberland and possibly Oxford Counties. Future efforts will focus on an inventory of additional sites and a documentation of extant populations of this state threatened reptile.

Acknowledgments

We would like to express our appreciation to the Endangered and Nongame Wildlife Project of the Maine Department of Inland Fisheries and Wildlife and the Natural Heritage Program of the Maine Chapter of The Nature Conservancy for financial support of our field work. Audrey Grumbling discovered the L Pond specimen and Jane Arbuckle of the Maine Audubon Society verified it. Frederick Jurgen found and identified the Lyman turtle. Lee Frinsko picked up the Saco specimen and Arlene Stackpole found the Sanford animal. Ed Dubrasky picked up the female on Bell Marsh Road and Dennis and Debbie Doughty photographed the animal crossing Route 5 in Limerick. To all of these alert and concerned observers go our thanks.

TABLE 1. Summary of Maine Blanding's turtle records (all from York County).

DATE	TOWN	LOCATION	SOURCE	VERIFICATION/COMMENTS
6/1960	Acton	Mousam Lake (shoreline)	Packard (1960)	Found by Capt. Albert Prosser, returned to Mousam Lake
6/1960	Waterboro	Unknown roadway	Packard (1960)	Found by Leroy Norton, DOR, gravid female, shell in his museum in Presque Isle
7/1966	Eliot	Unknown pond	Graham and Doyle (1973)	Adult female also verified by Dr. Philip Sawyer, released in Eliot
5/1980	Lyman	South Waterboro Road at Sunken Branch Brook, approx. 1 km SW of Grant Hill	MARAP ¹	Crossing road, no documentation, released same site 2 weeks later, adult female
5/1984	Saco	Bay View Road nr. Seaside Avenue, 0.6 km N of Long Pond	MARAP	Photos by J. Albright, MCZ-K909, K910, released north side Bay View Road, adult female
5/1985	Sanford	On dirt road just up from shore of L Pond	MARAP	Photos by M. Mills, MCZ-K907, K908, released L Pond
5/1985	York	Bell Marsh, 4.4 km N of Brixham Lower Cor., fyke net	TNC ²	Photos by T. Graham, MCZ-K905, K906, released Bell Marsh, adult female
5/1985	Shapleigh	Goose Pond, approx. 1 km N of Goose Pond Road, fyke net	TNC	Photos by T. Graham, MCZ-K905, K906, released Goose Pond, adult male
6/1985	Sanford	South shoulder of Rte. 109, approx. 1.3 km N of Rte. 4	MARAP	Photos by T. Graham, MCZ-K903, K904, adult female, released Curtis Pond near find site
7/1985	Alfred	Gebung Road	MARAP	Unconfirmed verbal report, picked up at night and released
6/1986	Limerick	Crossing Rte. 5, approx. 100 m N of Little Ossipee R.	MDIFW/TNC ³	Photo by Debbie Doughty, MCZ-K941, released Little Ossipee River
6/1986	Berwick	Beaver Dam Pond, baited funnel trap	MDIFW/TNC	Two gravid adult females, photos by T. Graham, MCZ-K934, K935, released same site
6/1986	York	Crossing Bell Marsh Road approx. 1 km S of Bell Marsh	MDIFW/TNC	Photos by T. Graham, MCZ-K939, K940, adult female, released Bell Marsh

MARAP¹ = Maine Amphibian and Reptile Atlas ProjectTNC² = The Nature Conservancy supported field workMDIFW/TNC³ = Field work funded by the Endangered and Nongame Wildlife Project, Maine Department of Inland Fisheries and Wildlife, and The Nature Conservancy

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AN INCIDENT OF TWINNING IN THE BOG TURTLE,

Clemmys muhlenbergii Schoepff

Reports of chelonian twinning are scant in the literature. Plymale et al. (1980) discussed this phenomenon in some depth and reported it in ten species of chelonians. The greatest instance of chelonian twinning occurred in *Chelydra serpentina* (23 of 2228 eggs) as reported by Yntema (1970). More recently, twinning in turtles was recorded by Cohen (1986) in *Terrapene carolina carolina*. The following account is believed to be the first recorded incident of twinning in the genus *Clemmys* and in *C. muhlenbergii*.

On 19 May 1986, four eggs were laid by a bog turtle collected in Henderson County, North Carolina 22 May 1982. The eggs were deposited in an outdoor bog at Zoo Atlanta in sphagnum moss at a depth of 50 mm. They were weighed on a triple beam balance and measured with vernier calipers within 24 hours of deposition (length, $\bar{x}$ = 32.7 mm; width, $\bar{x}$ = 15.7 mm; weight, $\bar{x}$ = 5.3 g). Nest temperatures were recorded daily using a Taylor dial thermometer (range, 15.7–34.7°C) and the eggs were monitored periodically until approximately the thirtieth day of incubation, after which they were checked every other day.

After 60 days incubation (20 July) the nest was opened to see if the eggs had pipped. Ants were observed preying upon the recently pipped eggs. The eggs were quickly removed and cleaned of ants. Three eggs were totally destroyed; all that remained were fragments of the neonates' carapaces. Egg #3 (length, 33.5 mm; width, 16.1 mm; weight, 5.4 g at deposition) was found intact with a small pinhole in the underside. When opened, twins were found joined at the yolk sac and appeared to be full-term. The dead twins were measured with the following data recorded: carapace length, 14.0 and 16.0 mm; carapace width, 12.5 and 13.0 mm respectively. With the exception of size, these turtles were identical to normal sized full-term preneonate bog turtles methodically.

I thank the staff of the Herpetology Department for recording nest temperatures in my absence. The twin *C. muhlenbergii* will be deposited in the North Carolina State Museum of Natural History.



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THE CONCEPTS OF SPECIES AND SUBSPECIES IN
UNIPARENTAL POPULATIONS, REFLECTED IN THE NOMENCLATURE OF
Cnemidophorus (Reptilia: Lacertilia)

Abstract

Parthenogenetic populational units cannot be defined in the same way as Mendelian (bisexual) units, but it is most expedient to utilize the same names (species, subspecies) for them, using distinctive definitions and concepts. A nomenclature for uniparental populations of *Cnemidophorus* is proposed using the Mendelian hierarchical framework.

The two most recent discussions of the proper approach to the nomenclature of uniparental taxa (Cole, 1985; Walker, 1986) have greatly clarified the state of knowledge of the parthenogenetic populations of *Cnemidophorus*, although they differ in conclusions. Cole (1985) recommends recognition of species, under a set of seven rules, whereas Walker (1986) recommends that the populations be designated simply as named complexes, not species (although available species-group names are adopted for them), each with two or more clonal populations designated by letter. Neither author seriously considers use of the subspecific category, although virtually all workers except Walker (1986) have accepted use of the specific category. It is here proposed that both categories be accepted in the nomenclature of uniparental populations, with definitions tailored to the peculiar needs of parthenogenesis, since the concepts of both species and subspecies have in the past been tailored to the situation that obtains in bisexual species. There is no more compelling reason to accept one category than the other for uniparental species.

That bisexual (Mendelian) species are real and natural entities, not simply human concepts, is now essentially apodictic. Equally incontestable is the arbitrariness of both phyletic and uniparental populational units, regardless of the categorical name or names applied to them. Numerous suggestions have been made to avoid use of the basically Mendelian terms species and subspecies for phyletic and uniparental populational units, but in practice at least the term species is so thoroughly entrenched as the populational equivalent of "kind" that it has proved futile to attempt to eliminate its use in any such context, even where its definition has to be arbitrary (in uniparental and phyletic populational hierarchies).

Therefore, although it is quite correct (Walker, 1986) that the Mendelian species definition is incompatible with uniparental populations, use of that term in the parthenogenetic context is inevitable, despite misoneism and misology.

If the term species is to be applied to uniparental populational units, then there is no defensible reason for not adopting also the Mendelian term subspecies. The only problem is how to define both categories. Since there are no natural units in parthenogenetic populations, as there are in Mendelian populations, the distinction between species and subspecies has to

hinge on degree of difference: uniparental species differ from each other in major ways, and subspecies differ from each other in minor ways (whereas in the Mendelian populational hierarchy, species are reproductively isolated, subspecies are not, except geographically in some cases; degree of difference is not a criterion except in the absence of information on reproductive compatibility). Uniparental subspecies also differ from their Mendelian counterparts in not necessarily being allopatric, whereas Mendelian subspecies regularly are. Sympatry of species can occur in both hierarchies.

It is obviously up to the specialists in each parthenogenetic group to determine what constitutes major and minor levels of difference, but that appears to be no major hurdle. The important point is that the term species, applied to primary populational units, and subspecies, applied to subdivisions of species, constitute a hierarchical system that is already universally understood and should be applied to uniparental populations as well as to Mendelian ones.

Walker (1986) has made it simple to apply the Mendelian system in the genus *Cnemidophorus*; he recognized six major uniparental complexes, each with two or more minor variants. Utilization of the Mendelian system for his hierarchies results in the following nomenclature:

1. *Cnemidophorus cozumela* Gadow
 - a. *C. c. cozumela* Gadow
 - b. *C. c. maslini* Fritts
 - c. *C. c. rodecki* McCoy and Maslin
2. *Cnemidophorus exsanguis* Lowe
 - a. *C. e. exsanguis* Lowe
 - b. *C. e. flagellicaudus* Lowe and Wright
 - c. *C. e. sonorae* Lowe and Wright
3. *Cnemidophorus laredoensis* McKinney, Kay and Anderson
 - a. *C. l. laredoensis* McKinney, Kay and Anderson
 - b. *C. l.* subsp. *innominatum*
4. *Cnemidophorus velox*
 - a. *C. v. velox* Springer
 - b. *C. v. uniparens* Wright and Lowe
 - c. *C. v. opatae* Wright
5. *Cnemidophorus tessellatus* (Say)
 - a. *C. t. tessellatus* (Say)
 - b. *C. t. dixonii* Scudday
 - c. *C. t.* subsp. *innominata*

6. *Cnemidophorus perplexus* Baird and Girard
 - a. *C. p. perplexus* Baird and Girard
 - b. *C. p. neomexicanus* Lowe and Zweifel

Adoption of this nomenclatural system opens the door to proposal of formal names to some of the minor variants listed by Walker (1986) and labelled only by letter. Still more minor variants are known in some cases, as he pointed out. Subspecific names for all of the more important minor variants would pose no real problem, since there are relatively few. Obviously good judgment dictates that the potentially far more numerous, trivially minor variants not be named.

Of importance in consideration of application of Mendelian terminology to uniparental populations is the International Code of Zoological Nomenclature. That Code contains no reference to uniparental (or parthenogenetic) populations, but it does concern itself marginally with hybrids, which account for all uniparental populations of *Cnemidophorus*. However, it is clear that the rulings of the Code in reference to hybrids are limited to non-populational, individual instances of successful interspecific matings. Names proposed for hybrids "as such" have (Art. 1(b)(3)) no status in zoological nomenclature, according to the Code, but names based upon animals later found to be hybrids remain available (Art. 17(a)), but cannot be used as the valid name for any parental species. Hence nothing in the Code prevents acceptance of names based on individuals representing uniparental populations of hybrid origin.

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THE STEM FOR FORMATION OF FAMILY-GROUP NAMES
FROM THE GREEK WORD OPHIS

Abstract

McDowell's innovation of *ophe-* instead of *ophi-* as the stem to which family-group name endings are added is correct, since the Code adheres to classical Greek rules, whereas *ophi-* is the stem in vernacular Greek.

Adoption by McDowell (1987) of *ophe-* as the stem of *ophis* for formation of family-group names, rather than *ophi-* as has been commonplace in the past, merits explanation.

Family-group names are formed, according to the 1985 (third) edition of the International Code of Zoological Nomenclature (and by all preceding editions and codices), by adding the proper endings (officially *-idae* for families, *-inae* for subfamilies, *-oidea* for superfamilies, and *-ini* for tribes) to the grammatical stem of the type genus. The grammatical stem is found by deleting the case ending of the appropriate genitive singular.

The genitive singular of *ophis* is given as *ophi-os* by Brown (1956: 723), Groves (1839: 430) and numerous other lexicons, and it is from this stem that the family-group names based on generic names ending in *-ophis* have become familiar, e.g., Hydrophiidae, Tropicophiidae, Sibynophiinae, Alsophiinae, Acanthophiini, etc.

However, Jaeger (1978: 175) gives *ophe-os* as the genitive singular of *ophis*, and Groves (1839: 430) notes that *ophe-os* is the spelling of Attic Greek. If so accepted, all family-group names based on generic names ending in *-ophis* would be spelled with an *-e-*, e.g., Hydrophidae, Trochidophidae, Sibynopheinae, Alsopheinae, Acanthopheini, etc.

Both spellings of the genitive singular are correct. However, the long-accepted stem *ophi-* is correct in Biblical Greek - the ancient vernacular of tradesmen and other lay workmen - and in minor dialects of classical Greek. The stem *ophe-*, on the contrary, is correct in Attic Greek, the dialect accepted as representative of classical Greek.

Appendix D of the Code gives an example in the Greek third declension (p. 223) that serves as the nomenclatural guide for *ophis*: *krisis*, the genitive singular of which is stated *kri-se-os*. That word likewise is listed in Groves (1839: 356) with the vernacular genitive singular *krisi-os*, but in Attic Greek, *kri-se-os*.

Since Attic Greek, and not minor dialects or Biblical Greek, is the model for zoological nomenclature, the correct stem for family-group names formed from *ophis* is *ophe-*, not *ophi-*.

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DO ORNATE BOX TURTLES PREY ON BIRDS?

The ornate box turtle, *Terrapene ornata ornata* (Agassiz), is a common turtle in Oklahoma (Webb, 1970; Secor and Carpenter, 1984). Yet little is known about the natural history and especially the diet and feeding habits of this turtle throughout much of its range.

Information on feeding habits of ornate box turtles in Oklahoma is based primarily on miscellaneous observations. Webb (1970) preserved an ornate box turtle from Oklahoma which disgorged flowers and leaves of spiderwort, *Tradescantia*. Marr (1944) collected ornate box turtles in Beaver and Harper Counties, Oklahoma, and also in Kansas, Texas, Colorado and Nebraska. He (Marr, 1944) captured turtles on rolled oats used to bait rat traps and observed turtles eating grasshoppers and trapped rodents. Ornate box turtles could catch grasshoppers "on the fly" and also ate caterpillars and robber flies in Cimarron County according to Ortenberger and Freeman (1930).

Dr. E. Norbert Smith (pers. comm.) has observed ornate box turtles eating grasshoppers and prickly-pear cactus fruits in Custer County, Oklahoma. An ornate box turtle was observed and photographed by Richard L. Lardie (pers. comm.) as it ate a road-killed rabbit in the middle of a highway in northwestern Oklahoma. The turtle continued to eat the carrion and would "duck" as cars passed over it.

The classic study of *T. ornata* in Kansas by Legler (1960) indicated ornate box turtles will eat practically anything and are unique in their utilization of dung communities as a source of insect foods. Ernst and Barbour (1972), Carr (1952), Collins (1982) and Smith and Brodie (1982) also pointed out the predaceous and carnivorous nature of ornate box turtles.

The following observation indicates that ornate box turtles are capable of predation on vertebrates such as chickens if the turtle can capture them. Legler (1960) reported observations of ornate box turtles eating eggs, one turtle with a blue down feather in its mouth, and another turtle catch and eat one of a brood of Bobwhite quail. Bones of an Eastern Cottontail (*Sylvilagus floridanus*) and a chicken were found in the stomach contents of a box turtle in Douglas County, Kansas (Legler, 1960).

During the first week of July, 1986, fifteen ornate box turtles were collected off the highways in the vicinity of Shawnee, Pottawatomie County, Oklahoma, by students in one of my classes. These turtles were contained on the floor of a small 1.5 x 1.75 m aluminum building. This building was also being used as a brooder house for fifteen purebred bantam chicks about ten weeks of age. I planned to leave the turtles in the enclosure with the chicks for one day until the turtles could be released back into the wild.

The next afternoon I looked into the building and saw two dead and partially eaten chicks on the sand-covered floor. One chick was a Rhode Island Red Bantam and the other a Birchen Modern Game bantam. Another

struggling Rhode Island Red chick was lying on the floor and a male ornate box turtle was pulling out its intestines and eating them. The intestines were being pulled out of an open wound directly below the cloaca of the chick. The skin area below the cloaca in Rhode Island Red chicks of this age is practically devoid of feathers and so thin that the intestines are visible beneath the skin. The other dead chicks also had open wounds in the area below the cloaca and they had been disemboweled through the open wounds. Heads and other parts of the chick's bodies had also been eaten by the turtles.

I observed one male ornate box turtle actively pursuing a Rhode Island Red chick. The turtle would stretch its head into the air and attempt to grab the chick at the posterior end of the body and in the area below the cloaca. Once the chick was grabbed, it was held by the turtle's beak. It was then relatively easy for the turtle to tear through the chick's thin skin with the use of the sharp claws on the turtle's forefeet and expose the contents of the abdominal cavity. The chick's intestines were then pulled out and eaten.

Ornate box turtles are opportunistic feeders but also capable of active predation on the young of birds. The opinion of some Oklahomans that ornate box turtles eat the eggs and young of some ground-nesting birds may have some validity.

Acknowledgements

A special thanks to Dr. E. Norbert Smith, Greg Sievert and Richard L. Lardie for their comments concerning this manuscript.

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—Jeffrey Howard Black, *Dept. of Biology, Oklahoma Baptist University, Shawnee, Oklahoma 74801.*

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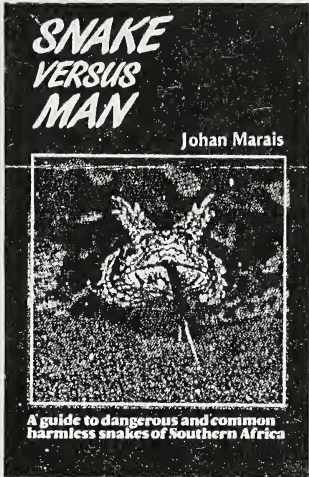
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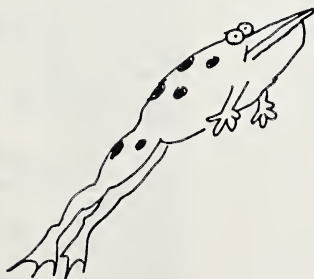
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INFORMATION REQUEST

All persons keeping live reptiles and amphibians are asked to contribute. Please submit the following information current January 1, 1987, for publication in the 1987 inventory.

- 1) A complete inventory of all reptiles and amphibians living in your collection as of January 1st. Sexes of adult animals should be included and should be listed male (1.0.0), female (0.1.0), unknown (0.0.1). Juvenile animals should also be listed using the same format. For example: 1.2.1 + juv 0.0.10 would be read: 1 adult male, 2 adult females, 1 adult of unknown sex, 0 juvenile males, 0 juvenile females, and 10 juveniles of unknown sex.
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NEWS AND NOTES:

ANNOUNCEMENT:



WORLD CONGRESS OF HERPETOLOGY

Tom Langton
Deputy Director
First World Congress of Herpetology
Rutherford College
The University
Canterbury, Kent CT2 7NX.

24th June, 1987.

Dear Sir/Madam,

I would like to introduce myself as a point of contact for the 1st World Congress in Canterbury 1989. I am sure that you will be pleased to learn that progress towards organising the Congress is going well, and I pass on to your Society the best wishes of our 1st World Congress Director, Dr. Ian R. Swingland.

In August this year, we will be printing a small 16-page circular giving details on the 1st Congress, and I am writing to ask if your Society would be prepared to circulate these leaflets to your membership as soon after August as possible. If this is acceptable, we will be pleased to send bulk copies to your mailing centre, and small numbers (less than 100) direct to other national addresses. Please let us know.

We very much hope that you will be able to support the Congress in this way and that this will not add significantly to your workload or mailing costs.

We would also appreciate being put on your general mailing lists for bulletins and newsletters until September 1989 if this is possible.

We look forward to seeing you at Canterbury in 1989.

With all best wishes,

Yours faithfully,

M. A. Pope

Tom Langton,
Deputy Director
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Dale Bertram, M.D.
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One Virginia Terrace
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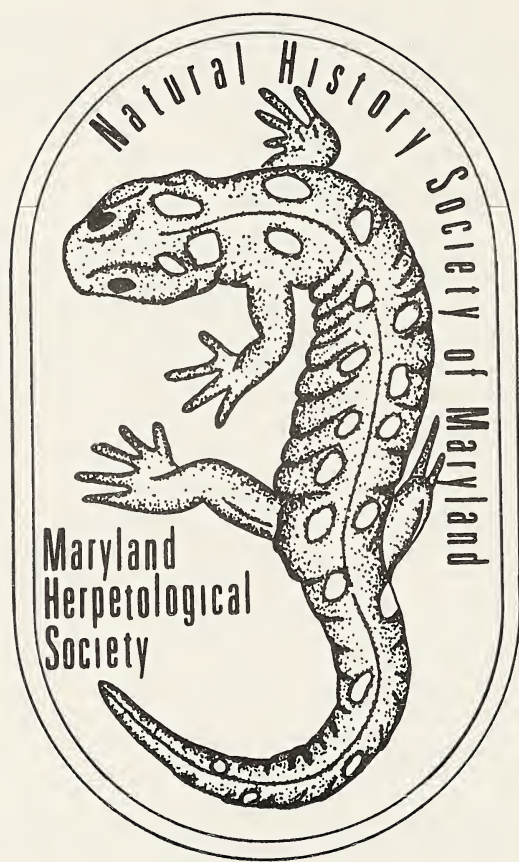
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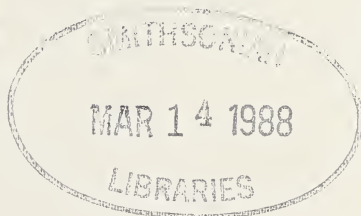


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December 1987

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December 1987

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THE LITERATURE ON SOMATODICHOTOMY IN SNAKES

Hobart M. Smith and Gonzalo Pérez-Higareda

Abstract

A survey of the literature on axial bifurcation in snakes adds 117 references to the 150 reported by Cunningham in 1937, and brings the total species in which somatodichotomy has been reported to 87 (species and subspecies, 99). All additional references, and all taxa concerned, are listed. Seven categories of dichotomy are recognized: craniodichotomy (=cephalic dichotomy and dicephaly [improperly bicephaly] of authors), prodichotomy (=anterior dichotomy of authors), proarchodichotomy, opisthodichotomy (=posterior dichotomy of authors), urodichotomy, amphidichotomy and holodichotomy.

Two-headedness and other sorts of axial fusion or fission in animals of all kinds have received highly disproportionate attention in comparison with other variations, and snakes are no exception. The literature has become so extensive, and the records so erratically duplicative, that a summary of current knowledge and informational gaps is in sore need for all groups. We here provide a survey for snakes.

Cunningham's (1937) remarkably thorough review of axial bifurcation in snakes reported its occurrence in 48 species and subspecies (several under two or more names), gleaned from the 150 references (1536-1933) compiled in that work, and from his own information. We here list 117 additional references published since Cunningham's work, or overlooked therein, bringing the total species of snakes in which somatodichotomy has been reported to 87 (species and subspecies, 99).

The systematic distribution of these taxa suggests that axial bifurcation can occur in any group of snakes, but most taxa of record (61%) belong to only three of the twenty-seven extant families (Dowling, 1986, system): Colubridae 22%, Natricidae 18%, and Crotalidae, 21%. Numerous families have very few or no observations of somatodichotomy. Furthermore, the anatomy of dichotomy is poorly reported, although an abundant terminology has been proposed for various degrees of dichotomy.

The earliest technical classification of types of ophidian somatodichotomy was provided by Nakamura (1938), who recognized two major sorts of duplicity: (1) *teratopagus* (G. terato-, abnormality, monster; G. pagos, fixed, unaltered), including three types exhibiting different degrees of fusion (*craniopagus*, fusion of the crania, rest of bodies and tail separate; *cephaloderopagus*, fusion of cranium and anterior trunk; and *anakatamesodidymus*, separation at both anterior and posterior ends, as well

as middle of trunk, fused elsewhere); and (2) *teratodymus* (G. *didymos* = dymus, double), including three types of anterior fission or "duplicitas anterior" (*rhinodymus*, double-nosed; *opodymus*, two-headed, often three-eyed; and *derodymus*, head and neck bifurcate). Obviously this does not exhaust all possible types of duplicity. Refinements were proposed by Belluomini (1965) and Lema (1982), but even these are not exhaustive, because the potential scale of extent and position of duplicity is obviously completely continuous; it is impractical if not impossible to name every possible conformation. The most exhaustive attempt is that of Antunes (1963), who provided names for over 60 different types of anomalous anatomical duplicity in vertebrates in general. Wilder (1904) has an excellent survey of the general literature up to that time.

Nakamura's (1938) nomenclatural system, and several subsequent elaborations, are not only cumbersome and unfamiliar in terminology, but are confusing by naming some conformations on the basis of degree of fusion, others on degree of fission. Obviously any given case of duplicity could be named from both points of view; it would be much better to name all from one point of view or the other.

Actually, every case of duplicity can be regarded as the result of incomplete division, not of fusion; hence *didymy* or *dichotomy* would be preferred as combining forms over *pagy*. Inasmuch as *dichotomy* is more familiar than *didymy*, it is the term of choice here.

Somatodichotomy is, then, always monozygotic twinning. Complete monozygotic twinning would be difficult to detect but undoubtedly occurs, and has been reported on rare occasion (discussion in Marion and Nowak, 1980). Dizygotic twinning has been reported several times (Marion and Nowak, 1980), but could never lead to fusion, complete or incomplete.

Cunningham's (1937) exhaustive review of axial bifurcation in snakes appeared before Nakamura's (1938) terminology was published, hence he adopted a simple classification into four types: cephalic dichotomy, anterior dichotomy, posterior dichotomy, and amphidichotomy. Tuck and Hardy (1970) concluded that Cunningham's system was preferable to Nakamura's because of cumbersomeness of the latter, and we agree on the same grounds as well as partial inappropriateness.

Nevertheless a certain refinement of Cunningham's system is desirable to provide preciseness of classification and brevity of terminology. We propose seven categories, as follows: (1) *craniodichotomy*, head only showing some degree of duplication, involving no more at most than atlas or axis (=cephalic dichotomy of Cunningham, and dicephaly of many authors [bicephaly is undesirable as a hybrid, Latin-Greek word]); (2) *prodichotomy*, head and at most anterior half of body duplicated to some extent, although not necessarily completely separate (=anterior dichotomy of Cunningham); (3) *proarchodichotomy*, more than anterior half of body, as far posterior as the anus (G. *archo*, anus), duplicated; (4) *opisthodichotomy*, only parts of body and tail posterior to head duplicated (=posterior dichotomy of Cunningham); (5) *urodichotomy*, only the tail or part thereof duplicated;

(6) *amphidichotomy*, both anterior and posterior parts, and rarely also some middle part, duplicated, most or all of middle parts single (=amphidichotomy of Cunningham); and (7) *holodichotomy*, complete duplication, of head, body and tail.

Since presumably somatodichotomy can occur in any species of snake, the vast differences in frequency of observation of the phenomenon in different groups appears to be correlated with ease of observation (diminutive species such as the scolecophidians having only one record), with individual abundance (common species having the most numerous observations), and with popularity in captivity (inasmuch as all the young are thus usually observed at once after birth or hatching). Most duplex individuals die as neonates, hence in nature have little chance of discovery by humans. Duplicity is at best a rare phenomenon, estimated by Belluomini et al. (1978: 117) as occurring in perhaps one of every 100,000 neonates. It is doubtful that there is a correlation with fecundity (except as that is reflected in commonness), and certainly there is none with parity type (since numerous observations have been made in both oviparous and viviparous groups). Captive inbreeding may play a role (Cooper, 1983).

In the Scolecophidia, for example, no records exist for the Anomalepididae or Typhlopidae, and only one for the Leptotyphlopidae. Following McDowell's (1987) classification for the most part, the following Alethinophidia groups lack observations: Acrochordoidea (with the extant family Acrochordidae), Anilioidea (Aniliidae, Cyliodropeidae, Loxocemidae, Uropeltidae, Xenopeltidae), Tropidopheoidea (Tropidopheidae), and the Bolyerioidea (Bolyeriidae). In the entire Booidea, only four species (and genera) have been recorded with somatodichotomy, although both families, and both subfamilies recognized by McDowell (1987) in the Boidae, are represented.

Following Dowling's (1986) classification of the Colubroidea, for the most part, the following groups lack records: Atractaspididae (with three subfamilies or tribes); Xenodermatidae; of the Dipsadidae, the Nothopsinae; Sibynophidae; of the Natricidae, the subfamily containing *Rhabdophis*, and the Hydraethiopsinae; and of the Colubridae, the Philothamninae, Calamariinae and Boiginae.

Of Dowling's (1986) Elapoidea, there are only 6 species (5 genera) recorded with somatodichotomy; records are lacking in the Elapidae for the Elapinae and Dendroaspidinae; in the Hydrophiidae, for the Laticaudinae and Ephalophiinae; and in the Acanthophiidae, the Acanthophiinae and Apisthocalaminae.

Of Dowling's (1986) Viperoidea, records are lacking in the Viperidae for the Azemiopinae and Causinae, and in the Crotalidae for the Lachesinae.

The species and subspecies for which records of somatodichotomy are available are listed in the following. Original records are cited only for publications appearing since Cunningham's (1937) synopsis, or missed in that work; otherwise, Cunningham is cited, with the number of references given

therein for each taxon. The suprageneric classification adopted is a combination of Dowling (1986) and McDowell (1987), with a few modifications.

SCOLECOPHIDIA. *Leptotyphlopidae*. *Leptotyphlops* *bicolor* (Branch, 1979). ALETHINOPHIDIA. BOOIDEA. *Boidae*. *Boa* *c. constrictor* (da Cunha, 1968; Lema, 1982); *Epicrates* *angulifer* (Cunningham, 1937, 1). *Erycidae*. *Eryx* *conicus* (Desai, 1984). *Pythonidae*. *Python* *molurus bivittatus* (Clark and Tytle, 1983). ALETHINOPHIDIA: COLUBROIDEA. *Boaedontidae*. *Lycophidion* *capense* (Broadley, 1975). *Colubridae: Colubrinae*. *Coluber* *constrictor* (Cunningham, 1937, 4, at least six specimens, part as *Bascanion constrictor*); *C. c. constrictor* (Tuck and Hardy, 1970); *Elaphe* *climacophora* (Nakamura, 1938; Satō, 1953; Niimi, 1965, 1971); *E. conspicillata* (Nakamura, 1938); *E. g. guttata* (Marion and Nowak, 1980, one-egg twins; Anonymous, 1984); *E. longissima* (Cunningham, 1937, 1); *E. obsoleta confinis* (Cunningham, 1937, 1); *E. o. obsoleta* (Burghardt et al., 1982); *E. quatuorlineata sauromates* (Iki, 1946; Amrakh, 1949; Alekperov, 1954); *E. rufodorsata* (Kuroda, 1919); *E. s. schrenkii* (Bakken and Bakken, 1987); *E. vulpina* (Cunningham, 1); *Hemorrhois* *florulentus* (Cunningham, 1937, 1, as *Coluber* (Zamenis) *f.*; *H. v. viridiflavus* (Vanni, 1979); *Lampropeltis* *sp.* (Cunningham, 1937, 1, as *Ophibolus* *sp.*); *L. calligaster* (Cunningham, 1937, 1); *L. getulus* (Cunningham, 1937, 5, as *Ophibolus* *g.*); *L. g. californiae* (Shaw, 1956, 1959, 1971; Ludicke, 1964; Shaw and Campbell, 1974; all preceding based on same specimen; Belfit and Nienaber, 1983, as *L. g. yuensis*); *L. triangulum* (Cunningham, 1937, 3, also as *Ophibolus* *dollatus* and *O. triangulus*); *L. t. triangulum* (Cunningham, 1937, 1; Ernst, 1965); *Ophedrys* *aestivus* (Cunningham, 1937, 1; Curtis, 1950, one-egg twins); *Pituophis* (Cunningham, 1937, 2); *P. melanoleucus affinis* (Keasey, 1969); *P. m. annectens* (Bellairs, 1981); *P. m. catenifer* (Cunningham, 1937, 1); *P. m. sayi* (Cunningham, 1937, 1); *Ptyas* *mucosus* (Brongersma, 1952); *Spalerosophis* *diadema* (Mishra and Majupuria, 1979). *Colubridae: Boiginae*. *Crotaphopeltis* *hotamboeia* (Cunningham, 1937, 1, as *Leptodeira* *h.*). *Colubridae: Lyeodontinae*. *Lycodon* *aulicus* (Cunningham, 1937, 2). *Dipsadidae: Dipsadinae*. *Sibynomorphus* *mikanii* (Laporta et al., 1983). *Dipsadidae: Leptodeirinae*. *Leptodeira* *annulata ashmeadi* (Belluomini and Lancini, 1960; Lema, 1982). *Homalopsidae*. *Cerberus* *rynchops* (Whitaker, 1971); *C. r. rynchops* (Cunningham, 1937, 1, as *Homalopsis schneiderli*); *Enhydrys* *enhydrys* (Talukdar, 1981); *Homalopsis* *buccata* (Smith, 1917; Cunningham, 1937, 1; Brongersma, 1952). *Natricidae: Natricinae*. *Amphisma* *vibakari* (Nakamura, 1938, as *Natrix* *vivakari*); *Natrix* *maura* (Blanc, 1979); *N. natrix* (Braun, 1893, fide Pflaumer, 1944, as *Tropidonotus* *n.*; Doe, 1915, as *T. n.*; Ladeiro, 1935; Cunningham, 1937, 6, as *Coluber* *n.*, *C. n. hirneus*, *T. n.*; Montalenti, 1937; Themido, 1944; Davies, 1976; Vanni, 1979); *N. n. helvetica* (Davies, 1973, 1974); *Nerodia* *fasciata* (Cunningham, 1937, 5, as *Natrix* *fasciatus*, *N. sipedon* *f.*, *Tropidonotus* *f.*); *N. f. fasciata* (Cunningham, 1937, 1, as *Tropidonotus* *f. fasciatus*); *N. r. rhombifera* (Oringderff, 1969; Burkett and Huggins, 1985, amphidichotomy); *Nerodia* *sipedon* (Cunningham, 1937, 6, as *Natrix* *s.*, *Tropidonotus* *fasciatus* *s.*); *N. s. clarkii* (List and Smith, 1954); *N. s. sipedon* (Cunningham, 1937, 1); *Regina* *septemvittata* (Cunningham, 1937, 2, as *Natrix* *leberis*, *Regina* *l.*; Neill, 1941, as *Natrix* *s.*; Goldberg, 1967; Tuck, 1974); *Rhabdophis* *tigrina* (Cunningham, 1937, 1, as *Tropidonotus* *tigrinus*; Nakamura, 1938, as *Natrix* *tigrina*); *Storeria* *dekayi* (Cunningham, 1937, 1; Triplehorn, 1955, extreme opisthodichotomy); *S. occipitamaculata* (Cunningham, 1937, 1); *Thamnophis*

elegans biscutatus (Cunningham, 1937, 1, as *T. ordinoides* b.); *T. e. vagrans* (Cunningham, 1937, 2, as *T. e. lineolata*); *T. marcianus* (Cunningham, 1937, 1); *T. radix* (Cunningham, 1937, 1); *T. sirtalis* (Cunningham, 1937, 6, also as *Eutaenia* s.; Nelson and Slavons, 1975); *T. s. concinnus* (Nickerson, 1966); *T. s. infernalis* (Cunningham, 1937, 1); *T. s. sirtalis* (Ditmars, 1936; Cohen, 1937; Martof, 1954, urodichotomy; Doyle, 1971); *Tropidoclonion l. lineatum* (Nickerson, 1966); *Xenochrophis piscator* (Cunningham, 1937, 1, as *Tropidonotus quincunciatus*; Singh and Thapliya, 1973, as *Natrix* p., one-egg twins; Talukdar, 1977). *Psammophidae*. *Psammophis* sp. (Cunningham, 1937, 1). *Xenodontidae: Heterodontinae*. *Heterodon platyrhinos* (Cunningham, 1937, 7; Meyer, 1958, two young, one dicephalic, in one egg; Nickerson, 1966); *H. simus* (Cunningham, 1937, 1). *Xenodontidae: Xenodontinae*. *Alsophis* c. *chamissonis* (Pflaumer, 1944, as *Dromicus* c.; Prado, 1946, as *Dromicus* c.; Lema, 1982); *Helicops carinicaudus infrataeniatus* (Lema, 1958, 1982); *Leimadophis almadensis* (Cunningham, 1937, 1, as *Liophis* a.; Lema, 1982); *L. p. poecilogyrus* (Prado, 1942, 1943, 1946; Belluomini, 1966; Lema, 1982); *Liophis miliaris* (Lema, 1957, 1982); *L. m. semiaureus* (Lema, 1956); *Philodryas olfersii* (Vizotto, 1975; Lema, 1982); *P. p. patagoniensis* (Prado, 1946; Belluomini, 1966; Gudynas and Gambarotta, 1981, one-egg twins); *Tachymenis peruviana chilensis* (Gunckel Luer, 1944a, 1944b); *T. p. peruviana* (Pflaumer, 1944; Prado, 1946; Lema, 1982); *Waglerophis merremii* (Belluomini, 1959, 1961; Lema, 1961, 1982). **ALETHINOPHIDIA: ELAPOIDEA. Acanthophidae: Notechinae**. *Notechis scutatus* (Cunningham, 1937, 1); *Pseudechis porphyriacus* (Longman, 1939). *Elapidae: Bungarinae*. *Hemibungarus japonicus* (Nakamura, 1938). *Elapidae: Najinae*. *Naja naja* (Cunningham, 1937, 1, as *N. tripudians*). *Hydropheidae: Hydropheinae*. *Hydrophis cyanocinctus* (Cunningham, 1937, 1, as *H. sublaevis*; Blanc, 1979); *H. spiralis* (Cunningham, 1937, 2, as *H. sirtalis*). **ALETHINOPHIDIA: VIPEROIDEA. Crotalidae: Crotalinae**. *Agkistrodon contortrix* (Cunningham, 1937, 1, as *A. mokasen*); *A. piscivorus* (Cunningham, 1937, 1); *Bothrops alternata* (Berst, 1945; Prado, 1946; Astort, 1981; Lema, 1982); *B. asper* (Pérez-Higareda and Smith, 1987); *B. atrox* (Cunningham, 1937, 2; Daniel, 1941, 1955; Dupouy, 1958; Belluomini, 1966; Lema, 1982); *B. jararaca* (Pereira, 1950; Belluomini, 1966; Lema, 1982); *B. jararacussu* (Pereira, 1944; Belluomini, 1966; Lema, 1982); *Crotalus adamanteus* (Klauber, 1956; Murphy and Shaddock, 1978); *C. atrox* (Murphy and Shaddock, 1978); *C. b. basiliscus* (Wiley, 1930); *C. durissus colliilineatus* (Vanzolini, 1947; Belluomini, 1966; Lema, 1982); *C. d. terrificus* (Cunningham, 1937, 1; Belluomini et al., 1974, 1978, Lema, 1982); *C. horridus atricaudatus* (Lasher, 1980); *C. h. horridus* (Rimkus, 1947, 1948; Anonymous, 1967; Harris, 1968); *C. s. scutulatus* (Kelly, 1909); *C. viridis oreganus* (Klauber, 1956); *C. v. viridis* (Klauber, 1956, amphidichotomy; McMullin, 1963); *Gloydus blomhoffii* (Yoshinaga, 1901; Cunningham, 1937, 2; Nakamura, 1938); *G. halys* (Niimi, 1971, proarchodichotomy); *Sistrurus c. catenatus* (Wright, 1940; LeWin, 1962); *S. miliarius streckeri* (Murphy and Shaddock, 1978). *Viperidae: Viperinae*. *Vipera aspis* (Cunningham, 1937, 2); *V. berus* (Leighton, 1901; Cunningham, 1937, 2, also as *Pelias* b.; Nybelin, 1942; Lagerlund and Hanstrom, 1961; Steward, 1961; Curry-Lindahl, 1963; Davies, 1976); *V. russelli* (Acharji, 1945; Deraniyagala, 1958).

We have made no attempt to classify all reports according to degree and nature of dichotomy observed. Cunningham (1937) gave such details for

reports up to the time of his publication, and Tuck and Hardy (1970) brought the classification up to 1970 from 1937. Suffice it to observe here, on the basis of the cited works, that craniodichotomy and prodichotomy are by far the most common conditions (about 85%); proarchodichotomy, opisthodichotomy, urodichotomy and amphidichotomy are all rare. Apparently holodichotomy (complete somatodichotomy) is possible, producing identical twins, but none of the several cases reported of twins from one oviparous egg are conclusive. Complete twins attached by one umbilical cord have yet to be recorded.

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THE AMPHIBIANS AND REPTILES OF TEXAS: A GUIDE TO RECORDS NEEDED FOR MEXICO

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Abstract

The distributional summary of the amphibians and reptiles of Texas just published by one of us (Dixon) reveals that at least 25 species and subspecies well known in that state have never been reported for Mexico, although occurrence there in several cases is a virtual certainty, and the others are to be expected. Records for Mexico of any of these 25 taxa are much to be desired and should be sought before elimination by habitat destruction.

The summary just published on the distribution of and literature on the herpetofauna of Texas (Dixon, 1987) provides an excellent opportunity to focus attention on the lack of records for species or subspecies in Mexico that are well documented just across the border in Texas.

Of the 283 different species-group taxa (DSGT) recorded by Dixon (1987) in Texas, 145 are known from Mexico. As many as 25 others could well occur there, with prospects varying from certainty to improbability although not impossibility. Those 25 include all DSGT shown on Dixon's maps as reaching the Mexican border, or counties thereon, but not yet recorded from Mexico, with three exceptions. *Eurycea neotenes* is reported from two border counties - Val Verde and Kinney - but is clearly restricted to the Edwards Plateau, which in that area ends in those counties. *Virginia striatula* is widely distributed in the mesic eastern half of the state, and is known from along the coast into Kenedy Co., some 70-80 km from the border but with habitats that extend well into Mexico. The former species is excluded from the list of 25, despite records for border counties, and the latter species is included even in the absence of border county records. *Trionyx m. muticus* is recorded from a border county (Maverick), but in error; since the species is now known no nearer Mexico than the Colorado River System in Mason and Llano counties, distant some 150 miles, it is not included in our list of 25.

Our purpose here is to focus attention on the fact that parts of Mexico immediately adjacent to Texas are still not well known herpetologically, can be expected to reward intensive study, and should be carefully surveyed before habitat alteration eliminates more species from marginal portions of their range than it already has.

The following 25 include no salamanders, four anurans, two turtles, the alligator, seven lizards and eleven snakes.

Scaphiopus holbrooki hurteri Strecker. Known from each of the southern four border counties (Zapata, Starr, Hidalgo, Cameron), this species seems virtually certain to occur in Mexico.

Syrrhophus marnocki Cope. Although largely restricted to the Edwards Plateau, this frog may well extend beyond it, much as *Hylactophryne augusti latrans* does in spite of being characteristic of the Plateau.

Hyla cinerea (Schneider). Occurring as it does along the coast into Cameron Co. (Conant, 1977, reviewed the Valley records), extension of the range into adjacent Mexico is likely.

Pseudacris s. streckeri Wright and Wright. Known from Willacy, Kenedy and Brooks counties, this species very likely extends southward through Cameron Co. into Mexico.

Chelydra s. serpentina (Linnaeus). No records are known closer to the border than Pecos, Real and San Patricio counties, but as indicated on Dixon's (1987:177) map 42, it is quite possible that the species extends to the Rio Grande down rivers, especially the Pecos and Devil's Rivers, in which it is recorded upstream.

Terrapene o. ornata (Agassiz). As widely known as this subspecies is from border counties from Val Verde to Cameron counties, it is astonishing that no records are yet known from Mexico, where it almost certainly occurs.

Anolis c. carolinensis Voigt. Known from Maverick, Hidalgo, Cameron and Willacy counties, the green anole is to be expected in adjacent Mexico. Conant (1977) noted early records from the Valley.

Crotaphytus c. collaris (Say). Like *Terrapene o. ornata*, this common, widely distributed lizard is surprising in its absence of Mexican records, for it is known from every border county from Hudspeth to Maverick counties.

Sceloporus merriami annulatus Smith. An inhabitant of the Big Bend, this subspecies should certainly be found across the Rio Grande, even though this species appears to be unusually susceptible to local differentiation.

Sceloporus merriami longipunctatus Olson. Like the preceding, this subspecies very likely extends at least a short distance across the Rio Grande into Mexico.

Cnemidophorus dixonii Scudday. So far known only from Presidio Co. in the Big Bend, the Gray-checked whiptail may be expected to occur in similar habitats but a short distance away in Mexico.

Cnemidophorus s. sexlineatus (Linnaeus). One of the surprises that defy explanation is the absence of records of this species in Mexico, in spite of known occurrence in every one of the border counties from Val Verde Co. to Cameron Co.

Ophisaurus a. attenuatus Baird. Glass lizards are among the rarest of lizards in Mexico, with isolated records of two endemic species - one in San Luis Potosi (*O. incomptus*), the other in Veracruz (*ceroni*), the two together known from less than a half dozen specimens. Yet another species,

O. attenuatus, also probably occurs in Mexico, since it is known all along the Gulf coast to the border Hidalgo and Cameron counties. The genus may well extend continuously along the coast from Texas to the Isthmus of Tehuantepec.

Cemophora coccinea lineri Williams, Brown and Wilson. The Texas scarlet snake has a limited distribution along the Gulf coast from Matagorda Co. to Kenedy, Brooks and Jim Hogg counties, but inasmuch as apparently suitable habitat extends into Mexico, it may well occur there.

Elaphe obsoleta lindheimeri Baird and Girard. The Texas rat snake occurs throughout virtually all of the eastern two-thirds of the state. Although records are sparser toward the Valley, those for Jim Hogg, Hidalgo and Cameron counties suggest that the species probably extends at least somewhat into Tamaulipas.

Lampropeltis c. calligaster (Harlan). Distribution of this species in Texas includes the eastern half of the state, with coastal records extending as far south as Willacy Co. Extension into adjacent Tamaulipas is reasonably possible.

Nerodia fasciata pictiventris (Cope). Introduced from its native habitat in Florida into the Brownsville area (Conant, 1977), this subspecies conceivably could extend its range into Mexico rather easily.

Tantilla rubra cucullata Minton. Rather widely distributed in the Big Bend region, although rare, this subspecies should occur in adjacent Mexico.

Tantilla rubra diabolus Fouquette and Potter. As rare as the preceding, but limited so far as now known to areas east of the Big Bend in Pecos and Val Verde counties, this subspecies also is to be expected in adjacent Coahuila.

Thamnophis cyrtopsis ocellatus (Cope). As a rare characteristic of the Edwards Plateau, this subspecies may not extend into Mexico, but its occurrence in the border county of Val Verde suggests that possibility.

Tropidoclonion lineatum texanum Ramsey. This prairie dweller occurs widely in central Texas, but is known no farther south than Duvall Co., some 80 km from the border. It may possibly extend into Mexico.

Virginia striatula (Linnaeus). The Rough earth snake occurs widely in mesic eastern Texas, and is known along the coast southward as far as Kenedy Co. It very likely extends through similar habitats into northeastern Tamaulipas.

Agkistrodon contortrix laticinctus Gloyd and Conant. The Broad-banded subspecies of the copperhead extends southward through central Texas at least to Kinney, Dimmit and LaSalle counties, and should occur in adjacent Mexico.

Agkistrodon contortrix pictigaster Gloyd and Conant. Widely distributed in the Big Bend area, the Trans-Pecos subspecies certainly occurs also across the Rio Grande in adjacent Coahuila, although no published record exists at present.

Alligator mississippiensis (Daudin). Known from almost all border counties south from Maverick Co., the alligator is, or has certainly been, an inhabitant of Mexico. Conant (1977) commented on early records.

Two other species merit attention in present contexts. Conant (1977) noted that *Agkistrodon piscivorus* (Lacépède) is reported from the vicinity of the Rio Grande at Eagle Pass and the "Mouth of the Devil's River." The species may have occurred at one time in adjacent Mexico, and indeed even yet may have "managed to survive in favorable isolated habitats near or along the river under otherwise arid conditions." There are, however, no modern records, hence Dixon (1987) quite properly excluded the vicinity of the Rio Grande from the projected range of the species. If the species does occur there, presumably the subspecies *A. p. leucostoma* (Troost) would be represented.

The other species is *Eumeces septentrionalis obtusirostris* Bocourt, which Vance (1987) recorded from Kenedy Co. (14 mi N Raymondville), extending the known range of the species about 185 km southward from Aransas Co. On this basis, this species also may be expected in Mexico.

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TAXONOMIC REVISION OF THE LIZARDS *Sceloporus serrifer*
AND *cyanogenys* OF THE GULF COASTAL PLAIN

R. Earl Olson

The populations of collared members of the genus *Sceloporus* inhabiting the Gulf Coast lowlands from southern Texas southward to Guatemala, thence northeastward to Yucatan have been partitioned under two species names for a century - *Sceloporus serrifer* Cope 1866 and *Sceloporus cyanogenys* Cope 1885. The two names have been retained throughout that time, most notably by Smith (1936, 1939), Smith and Taylor (1950), Martin (1958), Smith and Alvarez del Toro (1974), Smith and Smith (1976) and (by implication) Stuart (1970). This situation has been deepened by claims of the existence of competitive exclusion resulting in elevational zonation in southern Tamaulipas (and adjacent westerly populations), *S. serrifer* supposedly occupying low elevations, *cyanogenys* the highlands (Martin, 1958). This concept was further developed by Smith and Alvarez del Toro (1974) who envisioned that the elevational separation of the lizard species served as an illustration of ecological displacement of two closely-related species. Those authors, however, briefly addressed the question of relationships between *Sceloporus serrifer* and *cyanogenys*, concluding that 1) "the differences between the two species remain impressive", but 2) that the greenish dorsal color, unique among the *torquatus* group, "and the common occurrence in the Gulf drainage system, are strong indicators of possible relationship".

Having collected numerous specimens of *Sceloporus cyanogenys* throughout southern Texas, I identified a few specimens from Rancho del Cielo, Tamaulipas, a highland location, as *cyanogenys*, following Martin's (1958) argument. There was, in fact, little to call attention to their being different from any Texas specimens I had seen. Later work in lowlands of southern Tamaulipas resulted in obtaining specimens confusingly similar to *cyanogenys*. Reexamination of the preserved specimens from Rancho del Cielo several years later confirmed their identity as *serrifer*. The zonation argument became untenable, and this discovery has opened the door for reexamination of the relationships between *Sceloporus serrifer* and *cyanogenys*.

The present effort reviews characters, habitat, and factors of geographic range of the lizards named above. Examination of these characters was made for populations of *Sceloporus* specimens from southern Texas southward to the area of contact in southern Tamaulipas, relying heavily upon the work of Stuart (1970), especially for his comments concerning more southerly populations.

My primary objectives are: 1) to examine relationships between *S. serrifer* and *cyanogenys*, and 2) to survey the constancy of characters within the presently conceived range of *cyanogenys*.

Diagnostic Characters

Of the suite of characters listed as separating the taxa, two have been claimed to be consistent at the species level: 1) all supraoculars entire in *serrifer*; at least some divided in *cyanogenys*, and 2) rear supraoculars contacting median head plates in *serrifer*, but separated from them by intervening scales in *cyanogenys*. Also examined were body color, pattern, dorsal and ventral scale counts, femoral pore counts, and dentitional features.

Supraoculars - The entire or divided condition of the supraoculars (Figures 1 & 2) indicates several interesting trends. Generally, all specimens from southern Texas to southern Tamaulipas have some or most supraoculars divided, but that condition becomes less constant to the south. However, two interesting factors come to light: 1) there is a north-to-south decrease in numbers of divided supraoculars apparent from central to southern Tamaulipas and westward, and 2) specimens from the same or adjacent populations exhibit one or the other condition (Table 1). In many instances only a single supraocular is divided. The character is by no means constant in that area.

Samples from the following localities show divided supraoculars in at least some (but not all) specimens: NUEVO LEON: Marmalique Pass, 23.2 mi S Sabinas Hidalgo (4 of 13); TAMAULIPAS: Rancho del Cielo (above Gomez Farias); (1 of 9); Paño Ayuctle, 5 mi NE Gomez Farias (4 of 14); vicinity Rancho Santa Elena, 26.6 mi NW Juamave (2 of 4); vicinity Hacienda Acuña, 31 mi N Gonzales (19 of 26); VERACRUZ: Boca del Rio (3 of 5) (Map 1). Stuart (1970) showed that the presence of entire supraoculars, though very high, is not always at the 100% level in populations in northern Veracruz.

Supraoculars contact median head plates - The contact or separation of the supraoculars and median head plates (Figures 1 & 2) exhibit much the same geographic trends as with the supraocular condition noted above. In specimens from southern Texas to southern Tamaulipas, the supraoculars are separated from the median head plates by the presence of intervening scales. But in numerous populations from southern Tamaulipas and areas directly westward, either condition occurs.

Specimens from the following localities show separation of supraoculars and median head plates in at least some (but not all) specimens: TAMAULIPAS: Rancho Santa Elena, 26.6 mi NW Juamave (1 of 4); San Carlos Mts. (1 of 8); 6 mi NW Padilla (1 of 4); Sierra de Tamaulipas (29 of 33); VERACRUZ: Boca del Rio (3 of 5); Venta del Enero (1 specimen).

Again, the presence of divided supraoculars in 100% of specimens in populations scattered among those above shows geographic trends similar to those observed for divided for undivided condition of the supraoculars discussed above.

Further Considerations

Body Color - The greenish or bluish-green dorsal body color, peculiar among members of the *torquatus* species group, is well known. Basically, that color is a feature observed throughout populations of the Gulf Coastal Plain here under discussion, as well as farther south.

Pattern - Features of pattern bear such a similarity throughout the range considered that a distinct geographic continuity is what is observed. Ventral patterns are inseparable. Dorsal patterns are similar throughout. In the dorsal pattern are: 1) light spots on the dorsal head shields, (2) light nape spots, and 3) the nuchal collar (Figure 3). Light spots on the head shields are often observed. Most often a single spot occurs each on the parietal, postparietals, and posterior portion of the frontal. But it is not unusual that spots occur on other shields, especially the frontonasals. Light nape spotting is a feature common to most populations.

The nuchal collar, narrow or moderately wide (2.5 - 5 scales broad), is always complete with a continuous one-scale wide posterior border. The anterior light border is usually represented by 4 white spots arranged in a transverse line.

Dentition - The dentition is heterodont, anterior teeth being haplodont, posterior triconodont, a condition commonly observed in members of *Sceloporus* (Olson, et al., 1986, 1987). Triconodont teeth most often bear a sharply-peaked central cone, but flat central cones are observed in specimens from throughout the area of study.

Scutellation - As Stuart (1970) observed, comparisons of scutellation variation reveal no consistent geographic trends (Table 1), except in consideration of what he felt to represent terminal populations (i.e., in southern Tamaulipas).

The geographic situation as regards the characters shows 1) a constant expression of the two conditions of supraoculars (as discussed above) in southern Texas and northern Tamaulipas, and again to the south from northern Veracruz southward, but an east-west band of intermediacy in southern Tamaulipas and adjacent Nuevo Leon and San Luis Potosi. Such a band of intermediacy is precisely what would be expected in an intergrade situation (see Mayr, et al., 1953). Other characters are similar throughout the range discussed, so that, by reference to them, no taxonomic difference throughout the range is indicated.



Figure 1. Example of specimen with complete supraoculars and contact with median head plates (TCWC 52955).

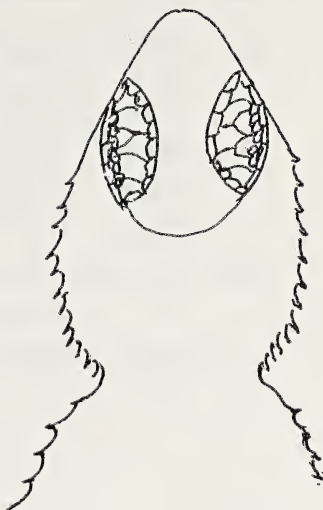


Figure 2. Example of specimen with divided supraoculars and no contact with median head plates (REO 624).

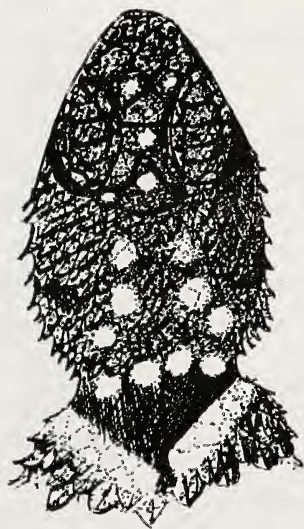


Figure 3. Head and nuchal pattern of specimen REO 1096.

Table 1. Meristic, mensural, and pattern data for populations of *Sceloporus serrifer*.

Pop. ²²	N=	Adult SVL	Dorsals	Ventrals	Fem. Pores	Supraoculars Entire?	Contact hd. plts?	Nuchal Collar Breadth
A	4	93.8 (74-108)	36.0 (35-68)	43.8 (41-47)	12.5 (12-13)	No	No	4.5 (4-5)
B1	9	117.6 (86-138)	36.4 (33-38)	44.5 (41-50)		No	No	
B2	8	92.4 (86-117)	38.0 (37-39)	44.3 (38-47)	12.6 (11-15)	No	No	3.5-5
C	8	101.5 (93-113)	38.6	43.4	13.7 (11-14)	No	No	
E	1	81	39	47	13.5 (13-14)	No	No	
F1	1	110	35	41	11.5 (11-12)	Yes	Yes	3.5
F2	4	94.3 (88-98)	38.5 (38-39)	42.3 (42-46)	11.8 (10-14)	No	No	
F3	1	79				No	No	3+
F4	13					4 Yes 9 No	No	
F5								
F6								
G1	9					8 Yes 1 No	Yes	
G2	1					Yes	No	
G3	2		33.7	41.7 (38-46)	15.0 (14-16)	No	No	
G4	4		36.0 (34-38)	42.0 (42-43)	14.8 (14-15)	2 Yes 2 No	3 Yes 1 No	1.5
G5	26					3 Yes 23 No	No	
G6	3		39	39	11.0	No (mod.)	No	
G7	8	95.0 (92-98)	39.0 (36-44)	50.3	13.5 (13-14)	No (mod.)	1 Yes 7 No	
G8	1	108	37	45	11.5 (11-12)	No	No	
G9	4		35.0 (34-36)	41	13.0	No (mod.)	1 Yes 3 No	
G10	3	94.0 (90-95)	36.0 (34-37)	41.0 (38-44)	13.0 (12-15)	No (mod.)	No	
G11	1	113	39	46	12.5 (12.13)	No (mod.)	No	
G12	1		33		11.5 (11-12)	No	No	
G13	14					10 Yes 4 No	Yes	
G14	35					No (mod.)	4 Yes 30 No	
H1	5		33.4 (31-34)	39.0 (31-41)	11.3 (10-12)	2 Yes 3 No	2 Yes 3 No	
H2	1		29	48	12.0	Yes	Yes	3.5-4
H3	1	83	34	45	12.5 (12-13)	Yes	No	

²²Localities are listed on the following page.

*Localities from Table 1 are as listed below.

- A: 1.6 mi N Jct. Hwys. 3075/649 on 642, Jim Hogg Co., Texas
B1: 2-5 mi SE Rio Grande City, Starr Co., Texas
B2: 1.9-6.1 mi W Sullivan City, Hwy. 83, Starr Co., Texas
C: Swatner-Hunter Ranch; 6.7-8.2 mi. NW Zapata, Hwy. 83, Zapata Co.
E: 3 mi S Sabinas Hidalgo, Hwy. 85, Coahuila, Mex.
F1: 51 mi N Sabinas Hidalgo, Nuevo Leon, Mex.
F2: 12.1 mi W Jct. Hwys. 40/53 (Monterrey By-Pass), Nuevo Leon, Mex.
F3: 1.8 mi N Cienega de las Flores, Nuevo Leon, Mex.
F4: Mammalique Pass, 23.2 mi S Sabinas Hidalgo, Nuevo Leon, Mex.
F5: 14 mi S China; Nuevo Leon, Mex.
F6: 3.3 mi W, 7.4 mi N Catarina, Nuevo Leon, Mex.
F7: 12 mi SW Ahautlan, San Luis Potosi, Mex.
G1: Rancho del Cielo, Tamaulipas, Mex.
G2: 26.6 mi NW Juamave, Tamaulipas, Mex.
G3: 4.8-6 km W Mamelejo, Tamaulipas, Mex.
G4: 23.5 mi NW Juamave, 4.3-7.3 mi SW Rancho Santa Elena, Tamaulipas, Mex.
G5: 31 mi N Gonzales, Hacienda Acuña - 2.7 mi S, Tamaulipas, Mex.
G6: Tula dump, Tamaulipas, Mex.
G7: San Carlos Mts., 5-9 mi SSE San Carlos, Tamaulipas, Mex.
G8: 40 mi SE San Fernando, Tamaulipas, Mex.
G9: 6 mi NW Padilla, Tamaulipas, Mex.
G10: Río Corona, Corona Parque Nac., 22 mi NE Cd. Victoria, Tamaulipas, Mex.
G11: 1 mi S Cd. Victoria, Tamaulipas, Mex.
G12: 18 mi S Cd. Victoria, Tamaulipas, Mex.
G13: Paño Ayuctle (5 mi NE Gomez Farias), Tamaulipas, Mex.
G14: Sierra de Tamaulipas, Santa Maria and Los Pilas, Tamaulipas, Mex.
H1: Boca del Río, Veracruz, Mex.
H2: 1 mi E Papantla, Veracruz, Mex.
H3: Venta del Enero, Veracruz, Mex.

Conclusions

A review of the several factors discussed above leads to the conclusion that it is the similarities, the absence of any consistent difference, that are obvious. What is being dealt with is but a single species. That species should be referred to as *Sceloporus serrifer*, in that the name antedates *cyanogenys*.

Furthermore, the data lead to the conclusion that *cyanogenys* should be regarded as a subspecies of *Sceloporus serrifer*. What is observed in southern Tamaulipas and adjacent westerly areas is precisely what would be expected in intergrade populations.

The taxonomic arrangement of subspecies of *Sceloporus serrifer*, as I presently perceive it includes four races. I do not find reason to accept *S. s. carniceps* (Martin, 1952). Some specimens in a few populations in southern Tamaulipas exhibit rugosity of head shields, a character supposedly diagnostic of that race, but the character is by no means consistent. Stuart (1970), in recognizing the subspecies, while rejecting *S. s. pliopus*, did so on the strength of the assumption that *S. s. carniceps* represents a terminal population, which is shown here not to be the case. The subspecies are as follows: *Sceloporus serrifer serrifer* Cope, *Sceloporus serrifer pliopus* Smith, *Sceloporus serrifer prezygus* Smith, and *Sceloporus serrifer cyanogenys* Cope (new combination).

Geographically, intergradation between *Sceloporus serrifer cyanogenys* and *S. s. pliopus* is considered to occur in a band across southern Tamaulipas through southmost Nuevo Leon and Central San Luis Potosí.

Specimen Examined

TEXAS: Jim Hogg Co.: TCWC 48209-48211, 48640 - 1.6 mi N Jct. Hwys. 3075/649 on 642; Starr Co.; REO 617, 621-624, 2197-2199, 3729, 2-5 mi SE Rio Grande City; TCWC 62220-221, 1.9 mi W Sullivan City, Hwy. 83; TCWC 62222-227, 6.1 mi W Sullivan City, Hwy. 83; Zapata Co.: TCWC 57020, Swatner-Hunter Ranch (Hwy. 85); TCWC 62219, 62230-235, 6.7-8.2 mi NNW Zapata, Hwy. 83; COAHUILA: TCWC 54448, 3 mi S Sabinas Hidalgo, Hwy. 85; NUEVO LEON: TCWC 57295, 51 mi N Sabinas Hidalgo, Rte. 85; TCWC 61107-61110, 12.1 mi W Jct. Hwys. 40/53 (Monterrey By-Pass); TCWC 61111, 1.8 mi N Cienega de las Flores (1600 ft.); TCWC 61112-124, Marmalique Pass, 23.2 mi S Sabinas Hidalgo; UMMZ 103317 (2 spcmns.), 14 mi S China; UMMZ 117466, 3.3 mi W, 7.4 mi N Catarina; SAN LUIS POTOSI: UMMZ 126234 (2 spcmns.), 12 mi SW Ahautlan; TAMAULIPAS: REO 1095-1096, UMMZ 111210-211, 102966-968, 102882, 104312, above Rancho del Cielo, 5 mi NW Gomez Farias; TCWC 52959, 26.6 mi NW Juamave; TCWC 55280, 62083, 4.8-6 km W Marmelejo; TCWC 52955, 23.5 mi NW Juamave, 7.3 mi SW Rancho Santa Elena on Hwy. 101; TCWC 52956, 52957, 5.9 mi SW Rancho Santa Elena on Hwy. 101; TCWC 52958, 26.6 mi NW, 4.3 mi SW Santa Elena; TCWC 57301-305, 57332, Hacienda Acuna, 31 mi N Gonzales; TCWC 57322, 57324, 57326-329, 57352-355, 57358-368, 2.7 mi S Hacienda Acuna; TCWC 61131-133, Tula dump; TCWC 62082, 5.8 km S San Carlos; TCWC 62160, 8.5 mi SSE San Carlos, TCWC

62160, 8.5 mi SSE San Carlos, Rancho San Francisco; TCWC 62161-165, 55317, San Carlos Mts., 0.8 mi WSW Rancho Carritos; TCWC 3920; 40 mi SE San Fernando; TCWC 6968-70, 55278, 6 mi NW Padilla; TCWC 27773, Rio Corona, 22 mi NE Cd. Victoria; TCWC 20785-786, Corona Parque Nac., ca. 15 mi NE Cd. Victoria; TCWC 35232, 1 mi S Cd. Victoria; TCWC 6872, 18 mi S Cd. Victoria; UMMZ 111191 (4 spcmns.) 111193 (2 spcmns.), 111194 (8 spcmns.), Paño Ayuctle, 5 mi NE Gomez Farras; UMMZ 102873 (11 spcmns.), UMMZ 102870 (10 spcmns.), 102871 (5 spcmns.), 102875, Sierra de Tamaulipas, Santa Maria; UMMZ 102874, Sierra de Tamaulipas, Los Pilas; VERACRUZ: TCWC 837, 26708-711, Boca del Rio; EAL 1604, 1 mi E Papantla; UMMZ 89314, Venta del Enero.

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FEEDING BEHAVIOR OF THE GLOSSY CRAYFISH SNAKE,
Regina rigida

Regina rigida belongs to the group of snakes referred to as the crayfish snakes. Reports on feeding behavior in *R. rigida* are limited to a brief description by Franz (1976). Controlled laboratory observations of feeding in *R. rigida* disclosed previously unrecorded behavior.

Materials and Methods

Three specimens of *Regina rigida* (SVL=310, 320 and 355 mm) were collected from Iberville, St. Martin and St. James Parishes in Louisiana. The snakes were housed in separate 37.85 liter aquariums each supplied with a pebble bottom covered with water to a depth of 3.8 cm. Free-floating artificial plants were added to provide cover and the aquariums were placed in a semi-shaded area. The snakes were offered hard- and soft-shelled crayfish (*Procambarus* sp.), juvenile bronze frogs (*Rana clamitans*), and hylid tadpoles. After offering the snakes the amphibians for five feeding periods with no positive responses, I provided only crayfish for the duration of the observations.

Each snake was fed two crayfish every five days. Complete feedings were observed for each snake using 10 hard- and 10 soft-shelled crayfish. Six of the feeding observations for each snake were timed using three hard- and three soft-shelled crayfish. Four additional feedings were interrupted for each snake to examine two hard- and two soft-shelled crayfish after the initiation of ingestion had occurred.

Results and Discussion

Conant (1975) listed frogs as food for *Regina rigida* but the definite preference for crayfish in this study suggests that bronze frogs and hylid tadpoles are not among the favored anurans of this species. The snakes showed no noticeable preference for either the hard- or soft-shelled crayfish although after the initial bite occurred the ingestion techniques differed.

Hard-shelled crayfish. Upon introducing a crayfish into the aquarium, the snake pursued, stopped, then lunged and bit the crayfish on the abdomen while simultaneously wrapping two and one-half coils toward the anterior of the crayfish's carapace. Primary constriction at the junction of the carapace and abdomen was observed, but the chelae were relatively free from the coils. In 85 percent of the feedings, visceral fluids were observed exuding from the carapace/abdomen junction. After constriction was complete, the snake disengaged its jaws and aligned its head with the crayfish's uropods and telson. Ingestion took place immediately after alignment was complete. The attack-to-ingestion time for the three snakes ranged from 266 to 283 seconds (mean=275 s.).

Examination of six of the crayfish after the initiation of ingestion revealed that they were immobile and appeared to be dead. However, the observed immobility might have been due to shock or nerve damage.

Franz (1976) noted that *Regina rigida* immobilized hard-shelled crayfish with coils but he did not mention if any physical damage to the crayfish was observed following constriction. Green and Burghardt (1978), in a review of constriction in modern snakes, failed to list *R. rigida* as a constrictor, although they did include *R. alleni*.

Soft-shelled crayfish. The snake approach and lunged at soft-shelled crayfish in the same manner as with hard-shelled crayfish, biting it on the upper abdominal area. After mouth contact was made, the snake wrapped a single coil about the crayfish or simply pinned it against the substrate. Once the crayfish was under control the snake released its jaws and ingested it abdomen first. The attack-to-ingestion time ranged from 165 to 184 seconds (mean=179 s.), which was about 35 percent faster than the attack-to-ingestion time for feeding on hard-shelled crayfish.

Examination of six of the crayfish after the initiation of ingestion showed that they were mobile and capable of escape. The use of different behavioral strategies by *Regina rigida* for ingesting hard- or soft-shelled crayfish following the initial attack bite, suggests that some sensory mechanism, perhaps in the mouth, allows the snake to discriminate between a potentially dangerous hard-shelled crayfish and a relatively harmless soft-shelled crayfish. The ability to make such distinctions would prove advantageous to the species since it would not have to waste time and energy constricting harmless prey.

Phylogenetic implications. Rossman (1963) suggested that *Regina alleni*, the most specialized crayfish-eating natricine, evolved from an ancestral proto-*rigida* stock. Franz (1977) closely studied feeding behavior in *R. alleni* and reported observations similar to those for *R. rigida*, although the ability of *R. alleni* to discriminate between hard- and soft-shelled crayfish by the initial bite has yet to be demonstrated. Both *R. alleni* and *R. rigida* use two and one-half coils to constrict their prey, their patterns of ingestion are similar, and their average attack-to-ingestion periods were comparable to within one second. The fact that *R. alleni* and *R. rigida* share the feeding technique of constricting crayfish, a behavior unique among natricine snakes, lends support to Rossman's (1963) contention that the two species are very closely related.

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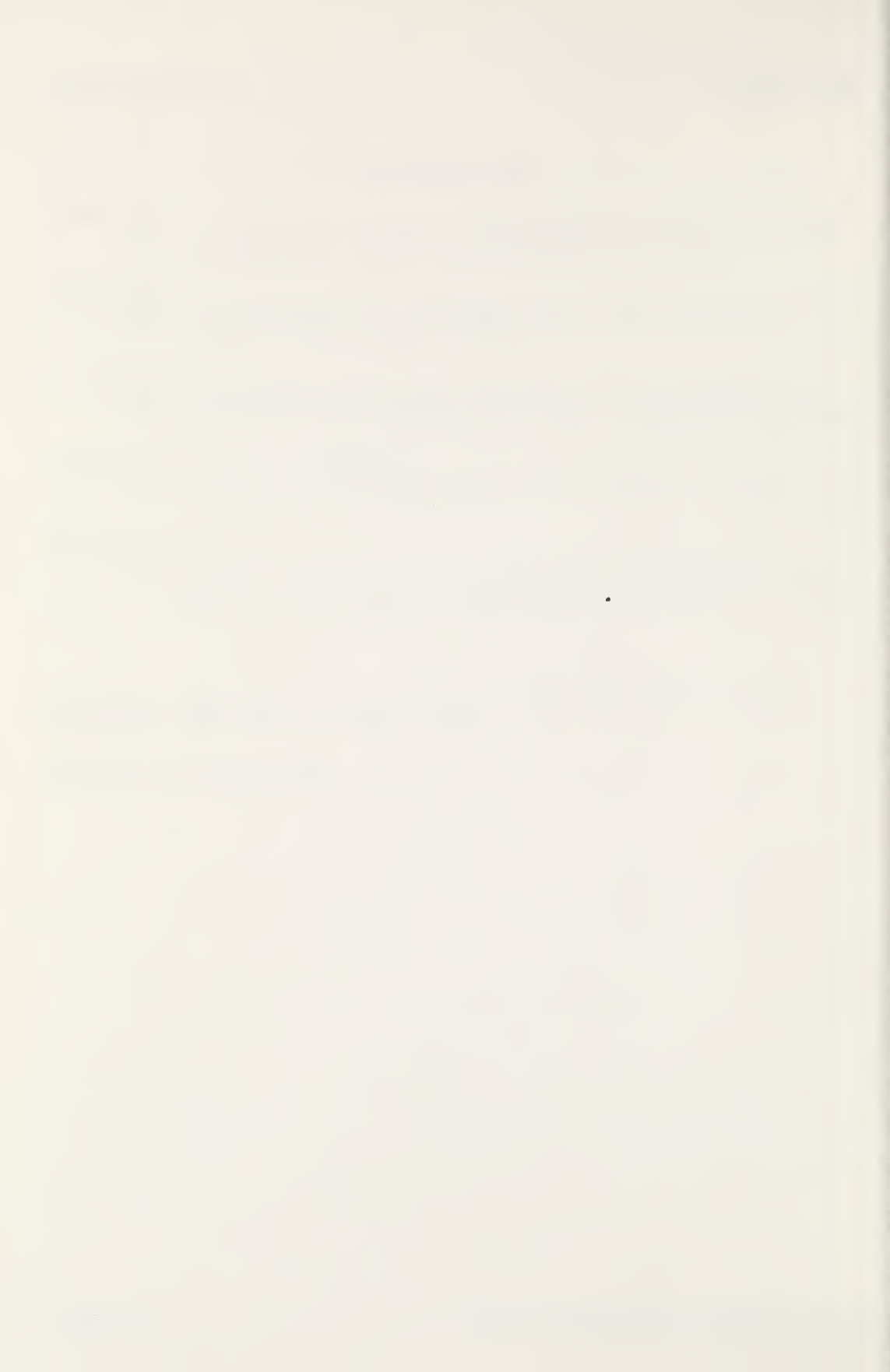
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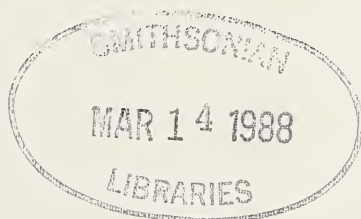
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VOLUMES 1-20

Compiled by Robert W. Miller



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EASTERN SEABOARD HERPETOLOGICAL LEAGUE

TABLE OF CONTENTS AND GEOGRAPHIC INDEX

VOLUMES 1-20

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Table of Contents,
Bulletin of the Maryland Herpetological Society,
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Robert W. Miller

Listed below, through an alphabetical arrangement of authors, are the contents of the Bulletin of the Maryland Herpetological Society, Volumes 1 through 20. Indexed are 439 titles by 221 contributors. Not included are a short-lived series of brief field notes called Maryland Herpetology, which appeared in 8(3) through 9(1), and two attempts at humor written during the Bulletin's early days. Thirty papers, all pertaining to the herpetology of Maryland, were reprinted in Volumes 1 through 7; one of these (Cooper and Groves) was published twice. All volumes have consisted of four numbers, with the exception of the first volume which had only one issue. Publication commenced in November 1965.

Despite the Bulletin's regional name, only one-third of its contents have dealt with the herpetology of Maryland. A geographic index has therefore been included and this follows the list of titles. A number of articles, however, are not identifiable with geography and are grouped at the end under the heading General.

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